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THE
BRITISH JOURNAL OF SURGERY

INTRODUCTION TO VOLUME VIII.

I GLADLY accept the kind invitation to write a prefatory note for the eighth volume of the JOURNAL, because it gives me the opportunity of saying a few words about "The Association of Surgeons of Great Britain and Ireland". Such an Association was very present in the minds of those who started the JOURNAL seven years ago; in fact they had already made up their minds to do their utmost to form one. They worked hard and strenuously, and by 1913 it looked as if their efforts would soon be crowned with success, and as if another year would see the Association firmly established, and adopting the JOURNAL as its megaphone, through which the word spoken in the ear might be, if desired, proclaimed upon the housetops. Five years of war have, however, upset all our calculations as to time; but they have not shaken the firm resolve that British surgeons shall have, not only a journal, but an Association worthy of their country.

During these five years the JOURNAL has appeared regularly in spite of the enormous rise in prices and in wages. It has been well supplied with papers dealing largely, but not exclusively, with the new military surgery, and now that the Association has at last emerged from its larval condition, the JOURNAL starts upon a new phase in its history.

It may be asked what the JOURNAL has to do with the Association anyway; and why it should utter a jubilant note at the Association's birth. The Association, it may be said, meets only once a year, and can only supply a modicum of the matter which will appear in the JOURNAL. I am not sure that this is true. The Fellows of the Association will, it may be hoped, freely bring their new facts—or facts supposed to be new—and their original ideas—or ideas supposed to be original—before the Association, knowing that they will not be at the mercy of reporters, and stimulated by the prospect of free and informal criticism. Then, chastened or elated as the case may be, they will take them back and incubate them. If they hatch out well, but only if they do, the chicks will be exhibited from time to time throughout the year as they mature and get into condition, and the produce of one meeting should not be exhausted before the next comes in sight. Another bond between the JOURNAL and the Association is that the Fellows of the Association will be receiving the JOURNAL throughout the year, and will thus be reminded that they belong to a body which is active and awake, not merely in a state of suspended animation except for a short spell in the month of May. Moreover, they are almost bound to read it. A quarterly periodical is not like a weekly journal which one has hardly time to open before the next number arrives. And our particular journal, if we may be allowed for the moment to boast, will by the excellence of its general get-up and the beauty of its illustrations force the Fellows to see what the articles are about. It is therefore obvious that the interests of the JOURNAL and those of the Association are inextricably combined.

The first meeting of the Association has now taken place, and everyone speaks of it as a delightful occasion, one for making new acquaintanceships and renewing old ones,

a time of instruction and even of inspiration. It is right, however, that we should thoughtfully take stock of it and make up our minds that, if in any ways it came short of our ideals, these particular shortcomings shall not be hardened into precedents for future meetings. I therefore venture, with all humility, to make the following observations.

For my own part I enjoyed the whole of it thoroughly; but when it was all over I was left with the conviction that, if the Association is to lead to real advance, its discussions will have to be more concrete and less didactic. To begin at the beginning: we all listened spell-bound to the fascinating and suggestive oration of the President, and we shall never forget it. It was quite right that the delivery of the inaugural address should be a formal and stately occasion; but if the time of the meetings is to be limited to two days and a half, I think that the opening address will have to be quite short—the concentrated quintessence of the President's wisdom—and that it should be followed by, and perhaps actually lead up to, the first full-dress debate. Then the second meeting might almost be called a brilliant intellectual display, but, in my opinion, the subject was too large for a profitable hour's discussion. I doubt if anyone was converted, or went away with his faith in the perfection of his own methods in the smallest degree shaken. This again was quite right for the first occasion; but another time we might perhaps do worse than take one small part of the vast subject, say, for example, "healing by first intention", which was only mentioned in passing, and see how our debate compares with the striking discussion at the International Medical Congress of 1881, and how far our views of this fundamental subject have matured in the last thirty years. The third meeting was intensely interesting; and it was inevitable, for the opportunity was a unique one. But we must guard against the danger of drawing the surgical intellect of the country together to hear lectures. We must bear in mind that the object of their coming together is for the interchange of thought and the expression of opinion; not merely for seeing one another's faces, but for hearing one another's voices; not so much for listening to discourses *ex cathedra*, as for traversing the statements of the expositors.

I hope it will not be thought ungracious of me to dwell thus upon matters which seem to me to be capable of improvement, rather than upon the undoubted merits of the first meeting. The latter are obvious to all and need no praise from me: the former are less likely to be formulated in thought or set down in words. It is only because the chance of saying what I feel has been unexpectedly put in my way, and because I am so anxious that the Association should be a real living success, and because I think that there is a danger that the 'defects of the qualities' of the first meeting may form the pattern for subsequent ones, that I venture to make these criticisms. And, having been so bold, I will make one more. We met this year in our overgrown and conservative old metropolis, bound by antiquated customs and leaning on ancient traditions. In the future we shall visit the smaller metropolitan cities and go-ahead provincial cities and towns. If we insist upon making our meetings severely business occasions, times of hard thinking and Spartan simplicity, I am confident that all that we hope and expect for the Association will be obtained.

RICKMAN J. GODLEE.

SIR WILLIAM BLIZARD.

1743–1835.

William Blizard was born at Barn Elms, near Mortlake, in Surrey, on March 1, 1743, being the youngest but one of the five children of William Blizard, an auctioneer. The family was remarkable for longevity; his father and mother died at the age of 86, his maternal grandmother at 90, whilst he himself attained to 92. After a scanty education at school, Blizard was apprenticed to Mr. Besley, a surgeon and apothecary at Mortlake, and signalized his apprenticeship by making a *hortus siccus* which was long preserved in the family. He was afterwards articled to Mr. Henry Thompson, one of the surgeons to the London Hospital, and he also acted as assistant to a surgeon in Crutched Friars. About this time he attended the lectures of Percivall Pott at St. Bartholomew's Hospital, and of William and John Hunter at the Hunterian school of medicine in Windmill Street. Of Pott he said in 1815: "By the lot of human nature few men can now record his talents as a lecturer; and in vain would be the attempt to describe the elegance of his language, the animation of his manner, the perceptive force of his truths and doctrines".

Blizard was admitted a member of the Corporation of Surgeons on February 6, 1772, and was soon afterwards appointed surgeon to the Magdalen Hospital, a post he resigned when he was elected Surgeon to the London Hospital on September 21, 1780, upon the death of his former master, Henry Thompson. He then became associated with Dr. Maclaurin, a Scotch physician, well known as a teacher of anatomy. Lectures were given at first in a small house in Thames Street and afterwards in Mark Lane. Blizard taught the surgery, which he was well able to undertake, as he performed all the operations at the London Hospital, his two colleagues Mr. Grindall and Mr. Neale leaving this part of the hospital duty entirely in his care. In 1785 he founded the first regular medical school in connection with a large London hospital. The Committee of the London Hospital gave the ground, whilst Blizard made himself responsible for the buildings which were erected at a cost of several thousand pounds. The school was opened on October 27, 1785, and the event was celebrated by an ode composed by Blizard, set to music by Dr. Samuel Arnold, and performed at the London Tavern, which was then one of the fashionable assembly-rooms for philanthropic meetings. He was invited to occupy the Chair of Chemistry at Guy's Hospital in succession to Dr. William Saunders, who had become physician to the hospital; but he remained faithful in his allegiance to the London, and undertook the lectures on anatomy, physiology, and "chirurgical pathology and practice" The lectures were largely attended, and attracted John Abernethy, who acted as his prosector. Abernethy always held Blizard in the highest esteem, and says of him: "He displayed to us the beau ideal of the medical character. I cannot readily tell you how splendid and brilliant he made it appear, and then he cautioned us never to tarnish its lustre by anything that wore even the semblance of dishonour".

Blizard loved the London Hospital with his whole heart, and devoted the main energies of his life to its welfare. He induced most of his wealthy patients to become governors, and in 1791 he was instrumental in establishing the Samaritan Fund, now known as the 'Marie Celeste', for the relief of poor patients when they left the hospital. In a public appeal for the fund he pointed out that "the greatest exertions of art and the most diligent care are extended to poor, sick, and hurt fellow creatures. But skill and tenderness will hardly avail against disease whilst the mind is continually depressed by reflection upon a hopeless prospect in life or upon the condition of a family pining with grief and want". Such sentiments carried into practice reflect the highest credit on Blizard's humanity, and the more so when it is remembered how great was the gulf which in his time

separated the rich from the poor, and how small was the consideration paid to the feelings of the poor by the majority of his contemporaries.

Blizard was public-spirited as well as philanthropic. From 1781 to 1790 he was surgeon to the Honourable Artillery Company; on resigning this office he was elected a member of the Court of Assistants, and in 1794 he became one of the trustees of the Company's estates. He was also an active member of the London Military Foot Association, which was formed for the purpose of supporting the civil power in the maintenance of peace and order. In this capacity he rendered valuable help during the Gordon riots in 1780, and Heath's engraving of the Broad Street disturbance shows Blizard in the foreground in the act of picking up a wounded insurgent, whilst another rioter is aiming a blow at him with a club and is restrained by a third, who seems to recognize him. Later in life he received a commission as lieutenant-colonel in the 6th Regiment of London Loyal Volunteers.

Blizard was elected Professor of Anatomy in the Corporation of Surgeons on July 5, 1787, and a Fellow of the Royal Society in the same year. His services as professor were duly appreciated, and on July 3, 1788, he "was unanimously re-elected, the usual gold medal being awarded to him". He was chosen a member of the Court of Assistants of the Corporation on January 7, 1796, and on the dissolution of the Company he was nominated a member of the Committee appointed to draft the charter for the present College of Surgeons which rose on its ashes. At his suggestion, his friend and pupil Samuel Jackson founded the prize in 1800 which is still known as the Jacksonian prize, and has led to the production of much sound surgical work and to the enrichment of the Museum. Blizard became a member of the Court of Assistants of the College of Surgeons in 1800, and continued to attend the meetings until his death in 1835. He became Master of the College in 1814, and filled the same office, with the title of President, in 1822; in 1812, 1813, and 1820 he was Governor of the College, and he delivered the Hunterian Oration in 1815, 1823, and 1828. It is evident that he had inherited considerable business capacity, for in 1811 "the grateful thanks of the College were presented to him for the extraordinary services he has rendered as one of the auditors, whereby the old and very complicated accounts have been settled and arranged, and a short and very clear mode of keeping them in future has been established". This resolution was proposed by his fellow auditors on the ground that they were the immediate witnesses of the services he had rendered. In 1803 Sir William received the honour of knighthood from King George III, on the occasion of his carrying an address from the College of Surgeons.

As might be expected, Blizard's energies were not confined to surgery. He became a Fellow of the Society of Antiquaries in 1779. He was one of the founders of the Anatomical Society, whose object it was to legalize the supply of subjects for dissection. He was amongst the early members of the London Institution. He was one of the first members of the Horticultural Society, over which he presided at the annual meeting when he was in his 93rd year. He was instrumental in establishing the Hunterian Society, and after serving as its first President in 1819 he was invited to continue for a second term of office.

In 1821 he left London and went to live at Brixton Hill, and in the same year the Governors of the London Hospital decided that "as it is most desirable to secure the connection of Sir William Blizard with the hospital during the remainder of his valuable life, and to provide for the discharge of his duties there with comfort to himself when the period shall arrive at which he may consider it necessary in some degree to relax his exertions: it was resolved that it be recommended to the General Court to appoint a surgeon as special assistant to Sir William Blizard, which appointment is to cease upon the demise or resignation of Sir William Blizard". He continued in office, however, until 1834, when he suffered from double cataract, and the lens of the right eye was successfully removed by Sir William Lawrence. He died of senile decay on August 28, 1835, having taken part in the College examinations seven days previously. He is buried in a vault in Brixton Church.

Sir William was tall in person, and his features were strongly marked. He was prone to jocularity, and would indulge himself in merriment on the prominence of his nose and

SIR WILLIAM BLIZARD
1743-1835

SCIENCE AND SURGERY.

THE INAUGURAL ADDRESS AT THE MEETING OF THE ASSOCIATION OF SURGEONS OF GREAT BRITAIN AND IRELAND, MAY 13, 1920.

BY THE PRESIDENT, SIR JOHN BLAND-SUTTON.

SURGERY is probably an ancient occupation like that of the gardener, cobbler, or potter. The gardener required few tools—a knife, axe, spade, and basket: also bast and fibre. The potter required fewer, and the astonishing results he produced with his fingers on a lump of soft clay, with the aid of a wheel, made a deep impression on the minds of thoughtful men. The potter's productions resembled creative acts, and this idea is emblazoned in the Jewish and Christian conceptions of the creation of man—God made man in His own image. Gods fashioned by the potter, *Dii fictiles*, were regarded with reverence by the Romans.

When the potter acquired the art of firing and glazing his clay productions, he made them imperishable.

Surgeons work on very perishable material and for their own time, for manual dexterity appeals only to witnesses.

Surgery is allied to cobblery. The tools of the surgeon and the cobbler are of three kinds: cutlery—knives and shears; implements for aiding manipulation—pincers and a last; and means for joining parts—threads, bristles, awls, or needles. Replace the last by a saw, and the tool-bag for each is complete. Denoted by their modern names—scalpel, scissors, saw, forceps, needles, sutures and ligatures—such a set of tools is sufficient for seventy-five per cent of the operations performed by surgeons.

Good craftsmen produce excellent results with simple tools. Modern surgical instruments are excellent in shape and quality, but at the time of the destruction of Pompeii, 79 B.C., tools used by surgeons were as gross as those of farriers and tinkers. The Pompeian mural painting preserved at Naples shows Iapyx attempting to remove the head of the dart from the thigh of Æneas. The wounded hero, supported by his faithful friends, Mnestheus and Achates, leans on his long spear; Ascanius, his son, weeps as the surgeon, with coarse forceps, tugs vainly at the dart. Venus, with her face muffled in a thin cloud, pitying but triumphant, supplies the tincture that releases the missile, heals the wound, and enables Æneas to fight again (*Fig.* 1).

Surgery should interest all. Everybody who survives birth is subject to a simple operation, omphalotomy, tying the navel cord. This simple act requires a piece of string and something with which to divide the cord. In the absence of knife, shears, a potsherd, or a piece of sharp flint, it may be bitten through, as in the case of animals. Surgery had its beginnings in such simple operations as omphalotomy, circumcision, and the sewing-up of wounds, and it remained a simple craft for centuries. The prime duty of the surgeon was the treatment of wounds and injuries: this involved the use of threads and needles, and implements for the reduction of dislocations.

OMPHALITIS.

Prehistoric midwives probably used the same kind of ligature-material that surgeons use to-day: fibre from plants, especially flax; tendon, catgut—in use for musical instruments—could scarcely escape employment as string; and silk. Though midwives tied the cord with string, surgeons did not appreciate its value for tying a cut artery until the sixteenth century, and it was in the latter part of the nineteenth that they learned the

dangers attending the use of dirty threads for such purposes. In my early days surgeons waxed the threads, like cobblers, with the hope of avoiding sepsis. The use of thread for tying the umbilical cord has had a dreadful post-operative mortality from general sepsis, the umbilical vein serving as the channel of infection. The literature relating to

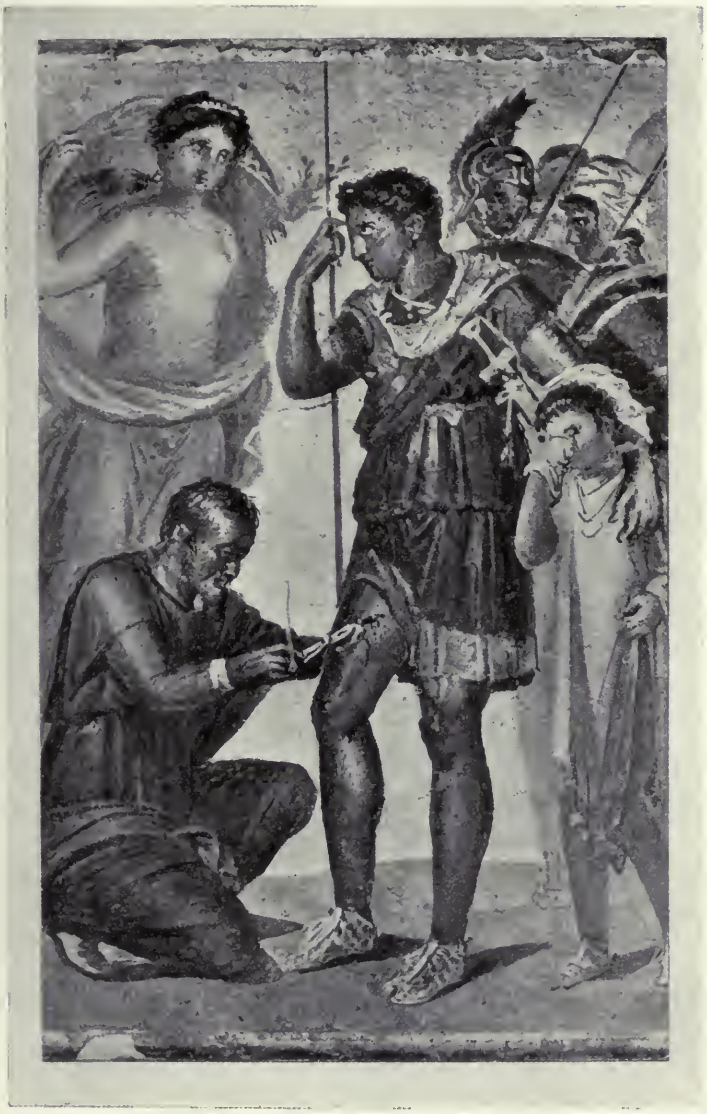

FIG. 1.—Æneas wounded. The surgeon Iapyx extracting the head of the dart from the wound in the thigh of the hero. *Æneid*, xii. (*Mural painting from Pompeii, Naples Museum.*)

omphalitis is extensive; Miller's account of the appalling infant-mortality from this cause in the Moscow Foundling Hospitals, published in 1888, and the well-known "scourge of St. Kilda", are examples of the deadly nature of this kind of wound infection.

Omphalitis has attracted much attention during the last thirty years, and now

strict surgical measures prevail in the birth-room, a new literature has sprung up relating to it, and as many methods are advocated for amputating the placenta as for removing a pile.

Endeavours to ascertain the cause of sepsis exercised the minds of the greatest surgeons. Seventy years ago the riddle seemed as insoluble as the cause of cancer appears to-day. Although the preparation of alcoholic beverages and bread by fermentation has been practised from remote periods, and festering wounds were as familiar as fermentation, and the rotting of dead plants and animals even more familiar, it was left to Pasteur and Lister to prove that these apparently dissimilar processes—fermentation, suppuration, and decay—are due to minute living organisms.

PARTICULATE CAUSES OF DISEASE.

The microscope enabled men to discover particulate causes of disease and to discern the manner in which they are distributed in the body. When we watch with a microscope the circulation of the blood in the web of a frog's foot, the passage of the red corpuscles through the capillaries is as exciting as our first glimpse with a telescope of Jupiter's moons or the belt of Saturn. Who, fifty years ago, on seeing the corpuscles whirling in the blood-stream, could imagine that in a few decades improvement in technique would enable pathologists to write of the flora and fauna of the blood with the same familiarity as that with which botanists and zoologists discuss the plants and animals special to a continent?

The distribution of minute parasites in the blood is instructive; some sport in the liquor sanguinis, some select the white corpuscles, and some the red. Grosser parasites use the blood-stream for transport to favourite sites for multiplication, and some permeate the walls of the arteries. Extreme minuteness to the microscopist is like enormous distances for the astronomer. One talks confidently in micro-millimetres, and the other in millions of miles. Who shall contradict them with equal confidence?

The Royal College of Physicians celebrates yearly the discovery of the circulation of the blood. The discovery of the lymphatic system was almost as important. Asellius found the lacteals by accident in 1622. He opened a living dog to investigate the action of the diaphragm, saw the lacteals filled with chyle, and recognized their nature. His enthusiasm would have led him to open living men as he had dogs, but he checked this inclination (Cruikshank). Now surgeons daily open living men and interfere with the stomach; in the course of such operations they can often show to the students lacteals turgid and white with chyle (especially if the patient has swallowed some milk two hours before operation: it is a common demonstration), and thus repeat the original observation of Asellius.

Cruikshank states that Harvey never believed in the existence of lacteals. We owe much to the zealous anatomists of the Windmill Street school, who investigated the lymphatics; now their origin, course, and termination in man's body are as plainly depicted in text-books as roads are delineated on motor-maps.

Lymphatics are the subtile channels by which infective material reaches the circulation for distribution—and mischief.

THE GLANDULAR PANTHEON.

One of the oldest occupations is that of shepherd, and the stockyard might not inaptly be called the cradle of physiology. For centuries shepherds have known that complete removal of the genital glands renders animals useless for reproduction, but makes them docile and fat.

Few suspected that other glandular organs were associated with growth and reproduction until it was discovered that complete removal of the thyroid gland induced myxœdema. Gradually the long-suspected relationship of the thyroid to cretinism was established. As with all knowledge that depends on observation, progress was slow:

"Precept must be upon precept, precept upon precept; line upon line, line upon line; here a little, and there a little". This surely applies to the slow accumulation of our knowledge concerning the potency of thyroid secretion. Its influence on growth has recently been studied experimentally on the metamorphosis of batrachians. Frog-tadpoles change into frogs precociously if fed on mammalian thyroid. A more striking effect occurs in the axolotl (*Fig.* 2), the tadpole stage of the tiger salamander, but it differs from the frog-tadpole by reproducing its kind whilst in the larval stage. When the axolotl was first brought to Europe, Cuvier shrewdly suspected it to be a larva. Many years later a captive axolotl lost its gills and frills, acquired movable eyelids, quitted the water, and became a terrestrial salamander (*Fig.* 3). Axolotls in this country occasionally transform, and J. E. Huxley has induced precocious transformation by feeding them on ox-thyroid. In his experiments the metamorphosis took place

FIG. 2.—Axolotl.

FIG. 3.—Tiger salamander.

in three weeks, as against seven to forty weeks (Madame Chauvin) and six to twelve weeks (E. G. Boulenger) under normal conditions.

Two structures in the body of vertebrate animals have always had for me a peculiar fascination—the notochord and the pituitary body; each is as constant as the backbone. The discovery of the influence of the pituitary secretion on the growth of bones opened the eyes of physiologists, and they slowly realized that the growth and development of animal bodies are governed by a glandular pantheon, and of the divinities in this curious pantheon the pituitary body presides over the growth of the skeleton.

It must strike even a casual observer as strange that two contrasted men such as Patrick Cotter, the Bristol giant, and the fat man, Daniel Lambert, weighing 739 lb., whose portrait adorned many tavern signs, were products of disordered glandular action (*Fig.* 4).

The discovery that Hunter's giant, Charles Byrne, alias O'Brien, had an enlarged pituitary body, is one of the romances of the museum. After Marie discovered the relationship of the pituitary body to acromegaly, surgeons became interested in studying its effects on the skeleton. Prof. D. J. Cunningham, during a visit to the museum, slipped his finger through the foramen magnum of the unopened skull of the giant, and found the pituitary fossa shallow and expanded : its walls had undoubtedly been levelled

FIG. 4.—Patrick Cotter, the Bristol giant, 8 ft. 7 in., and Daniel Lambert.
(*Kirby's Wonderful Museum*, 1804, vol. ii.)

by an enlarged hypophysis. Keith subsequently cut a movable lid in the cranial vault and made the eroded fossa available for easy inspection. Patrick Cotter was a contemporary of Hunter's giant in London. He had big hands, and a cast of one is preserved in the College Museum. Cotter was caricatured by Rowlandson in 1785, two years after Hunter's giant was dead and skeletonized. Grego, Rowlandson's biographer, describes the caricature as being drawn with skill and originality ; it represents the giant as

graceful though gigantic. In the picture, the giant's right hand is resting on the head of a military commander. The ladies are struck with wonder at such gigantic limbs, and one is comparing her tiny foot with the large and well-proportioned member of the giant (*Fig.* 5). The sketch contains other whimsicalities, and hangs in the conservator's office.

The most striking feature of giants, apart from their height, is the enormous size of their hands. This is shown in the drawing and in Rowlandson's caricature. These drawings were made nearly a century before acromegaly was detected or suspected.

Goliath of Gath, whose height was six cubits and a span (9 ft. 9 in.), had big hands, for the staff of his spear was like a weaver's beam.

FIG. 5.—The astonishing Irish Giant, 1785. (*Rowlandson.*)

I saw the hand of an acromegalic musician that could span 16 inches. This man played the double bass, and his wide span gave him excellent control over the strings.

It is strange that overgrowth of the most cunningly concealed glandular body in man is responsible for making its owner the most conspicuous person in an assembly. In spite of the apparent inaccessibility of the hypophysis in its neat little cave in the base of the skull, the radiologist can ascertain its dimensions during life with the same certainty with which he detects stones in the kidney.

Avian Clubs.—Some remarkable effects of glandular activity on the character and dress of birds may be studied in sparrows. In winter these birds, cocks and hens, live in flocks, and their twittering in the trees at sunset is a familiar feature in the dull

season. These societies may be called avian clubs, and they are sociable meetings, for in winter the testicles of the cocks are about the size of the pips of pippins (*Fig.* 6). In March, as the days lengthen and there is more sunshine, the testicles enlarge, and in May they are as big as sparrows' eggs. Apart from the special reproductive functions associated with the testicular increase, there are two features of importance: the colour of the feathers is more vivid, and the bird becomes pugnacious and combative. The sparrow is such a common bird that most of us take as little notice of it as of the Litany, but the nut-brown plumage of the cock sparrow in April is exquisite, when with trailing half-spread wings he deploys before the coy hen, and is so absorbed in the pursuit as to forget the presence of man.

Jackson's whydah bird presents a good example of resplendent nuptial plumage. This bird is closely allied to the sparrow, and in the quiet season it is difficult to distinguish by plumage the cock from the hen. On the approach of the pairing season the cock undergoes an extraordinary change. All the feathers except the primaries and secondaries become black (*Figs.* 7, 8). The tail feathers lengthen and assume a sickle shape.

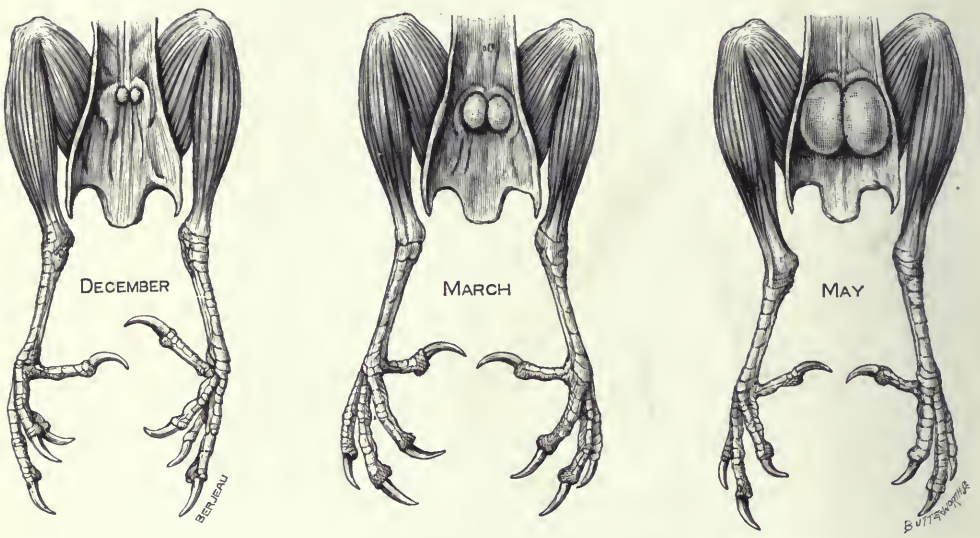

FIG. 6.—Seasonal changes in the sparrow's testicles.

In flight, the tail spreads out like a parachute, and the bird seems to float rather than fly. During courtship the cock indulges in extraordinary antics, in which wings and tail play a conspicuous part. At the end of the breeding season the cock moults, and cocks and hens live in communities, consisting of thousands, among the reeds.

It is remarkable that this finch in a few days produces a large amount of feathers, large in comparison with its bulk, and as black as ink. The source of the pigment is unknown. I often think that if its source were known, much of our ignorance in regard to melanoma would be dissipated.

It is a simple question to ask, Why does the cock have such fine plumage for the ceremonies of courtship, whilst the hen is covered with sombre feathers? It is more puzzling to explain why a hen, when she grows old and ceases to lay eggs, occasionally becomes cock-feathered.

In 1917 the College of Surgeons acquired the drawing of a duck (*Fig.* 9) feathered like a drake, even to the curly feathers on the tail. Under the drawing, in John Hunter's handwriting, is the statement that the bird made a noise sometimes like a duck and sometimes like a drake. The sexual difference in the voice of the duck and the drake

is well known, and is associated with a modification of the syrinx. In the drake there is an osseous bulb (*Fig.* 10) or labyrinth connected with the trachea and syrinx. The quack of the duck is loud and sonorous; of the drake, inward, harsh, and feeble. On a dark night, when these birds assemble by hundreds in marshes and shallow estuaries, they quack apparently for the sake of keeping company (Gilbert White). It is easy to distinguish the voice of the duck from that of the drake. It would be useful to ascertain if drake-feathered ducks also acquire a labyrinth to their syrinx.

FIG. 7.—Jackson's whydah birds, cock and hen.

Testicles and Feathers.—The relationship of testicles and feathers has practical importance for the ostrich farmer. Stanley Elley, a veterinary surgeon, practised the caponizing of ostriches in South Africa to check the breeding of inferior birds. The operation also enhances the value of feathers, tames vicious birds, and produces good parents. Sir Arnold Theiler informed me that during the war caponization practically ceased because of the slump in ostrich feathers, and the number of birds has enormously decreased.

In a bachelor ostrich the testicles weigh about an ounce, but in an old cock a pair weigh about 2 lb. The operation is not difficult, the risks are small, and the bird seems immune to peritonitis. In the hen the ovary is removed with good results. In cocks

the effects of castration on the feathers is due to the subsequent docility of this combative bird. Fighting spoils feathers. In the hen the value of the feathers is enhanced because the bird becomes cock-feathered and the feathers tend to become black.

A critic may ask, What have testicles to do with feather production when a hen without any trace of ovarian or testicular tissue becomes cock-feathered ? The evidence suggests that the endocrine glands are closely correlated in sex manifestations. Morgagni is credited with the observation that there is relationship between the development of the cerebral cortex and the cortex of the adrenal, but it is a modern discovery that

FIG. 8.—Jackson's whydah bird dancing in its playing-ground.

the adrenals are associated with the activity of the sexual organs. Mott regards the adrenal cortex as a storage of lipoid : in the fœtus it builds up the myelin of the developing nervous system, but in adults, as occasion arises, this lipoid can pass into the blood and keep constant the supply for the reproductive organs, where it serves as raw material for formative nuclear activity, an action essential for the production of spermatozoa.

The hormone secreted by the genital glands must be very potent, for the engrossment of the sexual act is such that amplectant frogs are often transfixed by inquisitive boys with sharp sticks, and Phinehas, Aaron's zealous grandson, treated a man of Israel and a

Midianitish woman in the same fashion with a javelin (Num. xxv. 7). Shackleton has collected photographic evidence that love is as ardent among birds and beasts

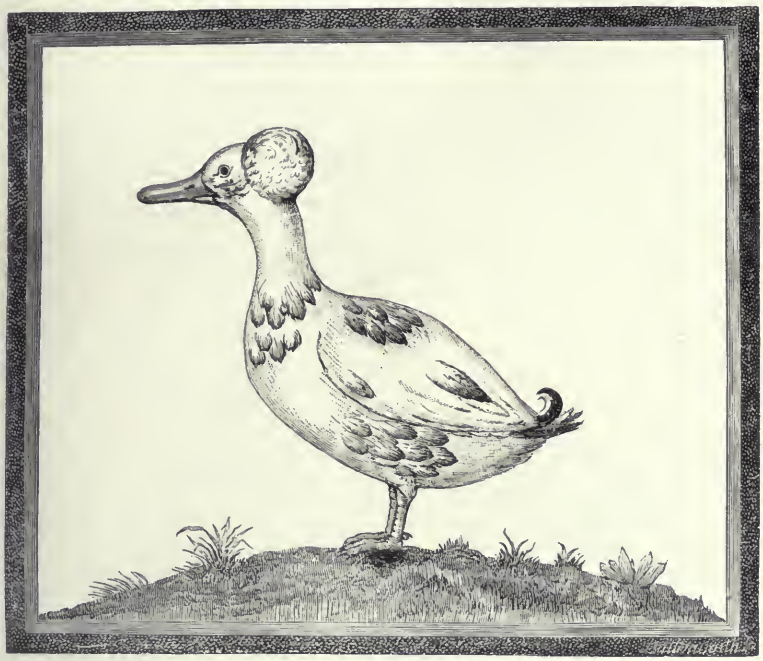

FIG. 9.—Duck in drake plumage.

during the cold summer of the Antarctic as in the heat of the Torrid Zone.

The enterprising spirit of South African veterinary surgeons is matched by their colleagues in Canada and the United States, where they make skunks as respectable as castrated cats, and much more profitable. Young skunks are obtained in May, as soon as their eyes are open, for then they are easily weaned and will eat bread and milk. The anal glands—scent-sacs they are euphemistically called in America—can be easily, safely, and almost painlessly excised in the young skunk. This operation—called 'disarming the skunk'—requires for its performance a scalpel, forceps, clamping forceps, hook, probe, and a pair of goggles. The clamping-forceps prevent the escape of the stinking fluid, and the use of goggles saves the operator's eyes in case of such an accident.

A disarmed skunk makes a good pet, and may be carried about like a kitten: it eats dead fowls, mice, fruit, vegetables, grubs, and beetles.

Skunk fur is admired by women, and the fur can be improved by cross-breeding.

Among other advantages claimed for a disarmed animal, is this: a tame skunk placed in the window of a store for advertising purposes will draw a big crowd.

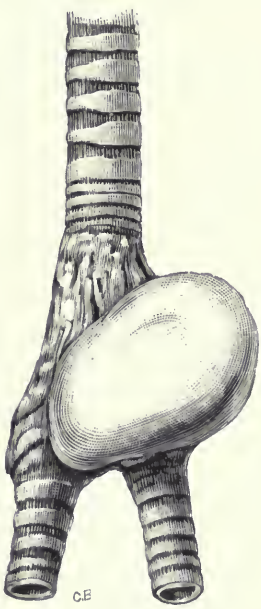

FIG. 10.—The syrinx of a drake (*Anas boscas*).

EMBRYOLOGY.

Next to speculations on the beginning of the world, nothing absorbs attention more than the origin of life, and the production of animals out of themselves always excites wonder and curiosity. The relationship of embryology to surgery has always had for me an irresistible attraction. I vainly imagined that embryology would help to solve the problem of the origin and growth of tumours, and a large part of my leisure for many years was devoted to this question. Of all tumours, dermoids attracted me, especially those which arise in the ovary. In relation to these singular tumours, which fifty years ago were regarded as curiosities, much has been learned, and the chief light on their origin has come from experimental embryology.

Patient section-cutting, and observation in the laboratory, proved that the tissues of the embryonic rudiment in an ovarian dermoid contained imperfectly developed tissues, and organs of an embryo—skin, hair, glands, teeth, cartilage, bone, trachea, thyroid gland,

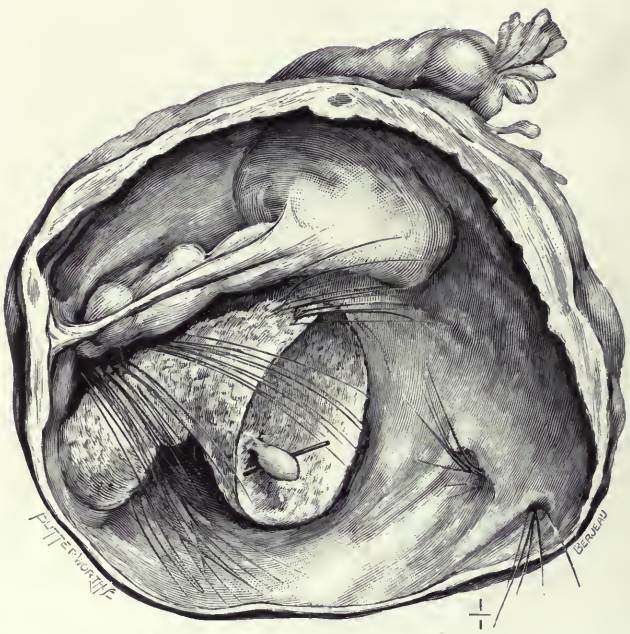

FIG. 11.—Ovarian dermoid. The small oval structure in the embryonic rudiment is invested with stout fibrous tissue, and contains nerve cells and medullated fibres. (*St. Thomas's Hospital Museum.*)

brain, eye, spinal cord, and (rarely) intestine, but so far no reproductive glands. In an embryonic rudiment in an ovarian dermoid removed from a woman, age 30, Shattock isolated a small oval structure invested with a capsule of stout fibrous tissue which, as told microscopically, contains nerve cells and some medullated fibres (*Fig.* 11). It gradually dawned on pathologists that these conglomerations of fœtal tissues could only be produced by the activity of an ovum; but observational embryology led men to believe that an ovum could only be stimulated by a spermatozoon of its own species. Since the discovery that mechanical stimulation is sufficient to start segmentation in an ovum, it has become a commonplace experiment in biological laboratories to irritate frogs' eggs with delicate stylets and produce what are now known as 'fatherless frogs'. These successful experiments indicate that ovarian dermoids might not inaptly be called 'fatherless embryos'.

These experiments can only be carried out on large eggs like those of the frog and its

kind. The method is not available for the production of race-horses, nor for heirs to ancient titles or great estates, when the sire is impotent : nor is there any reason to believe that it will relieve human beings of what St. Paul politely styles evil concupiscence (Colos. iii).

LAMPS AND SPECIALISM.

Before the invention of the incandescent lamp, the chief specialities rested on instruments that reflected sunlight, lamplight, or gaslight. By such simple means advances were effected in laryngology, ophthalmology, and gynæcology. The incandescent lamp enabled ingenious instruments to be constructed for illuminating internal cavities. To this class belong the cystoscope, bronchoscope, and sigmoidoscope. Each instrument requires skill in employment and experience in interpreting things seen. This accounts for much dismemberment in clinical surgery.

Radiology has transformed the methods of diagnosis in respect of intrathoracic disease. Good skiagrams of the chest will reveal calcified lymph-nodes, tumours of the mediastinum, and aneurysms of the big vessels. With the help of an opaque meal an intrathoracic stomach has been identified, and an œsophageal diverticulum can be localized and its size and suitability for removal duly estimated.

In the case of a foreign body in the chest, the utility of the x rays has long been demonstrated, and the detection of a sovereign or a bicycle—a toy bicycle—in the gullet excites curiosity, but it is a dramatic spectacle to watch a shrapnel ball in a cardiac ventricle, rapidly moving in its orbit, and recalling, in its activity, Phobos, the little satellite of Mars.

The chest is now an established field for surgical enterprise. There are indications that x-ray lamps and screens will be as available in wards and consulting-rooms as incandescent lamps are to-day.

The art of surgery is now so wide that no man can expect to be expert in all branches. Specialization is a necessity of modern surgery ; the Association will help to concentrate the results and keep surgeons abreast of the progress made in the great hospitals of the kingdom. Apart from the regular discussions, personal conversations will be even more useful, and promote good fellowship among surgeons.

Before all things let us remember that fellow-craftsmen should not be competitors, but comrades of the same honoured craft or guild.

DUODENAL DIVERTICULA.

By EDMUND I. SPRIGGS.

With Radiographs by O. A. MARXER.

In the last thousand consecutive *x*-ray examinations of the alimentary tract made at Duff House with an opaque meal, diverticula of the duodenum have been noted ten times. Although such diverticula are uncommon, the shadows they cast on the screen or plate may cause confusion unless their nature be recognized; and they may in rare instances give rise to symptoms.

Morgagni is said to have been the first to describe a typical pouch of the duodenum, and the statement is copied from author to author throughout the literature. A perusal of his account, however, leaves me in doubt. He refers in two letters commonly cited, and in at least three others, to excrescence, pedicle, prominence, or lacerated flap about the ring of the pylorus; but the description suggests other forms of pedunculated tumour; and in a case he mentions more than once, it appears from the context that the tumour lay inside the lumen, for he remarks that it might have obstructed the pyloric opening. An earlier case, that of Chomel, also often referred to, is probably of a different nature, as the cavity contained numerous stones. A pouch of the small intestine is mentioned, with several references, in a note by the translator, Soemmering, of Matthew Baillie's *Morbid Anatomy* in 1794, though it is not clear whether Meckel's diverticulum is included. In this country Habershon (1857) referred to duodenal diverticula. Perry and Shaw in 1893 gave a detailed account of non-inflammatory pouches, based on fourteen examples. Buschi, of Bologna, in 1911, collected fifty-four cases of which exact accounts were available, including three of his own. He referred to sixty-two previous authors, including Rolleston and Fenton (1901), and Keith (1903). Two years later Wilkie wrote a good summary, with fresh cases and excellent illustrations of post-mortem specimens. In 1917, Ritchie and McWhorter had found seventy-six cases in the literature, and published a radiogram of a case under their care. They mentioned that eleven others had been reported by radiologists, some of which had been corroborated at operation.

Duodenal pouches may be caused by ulceration or other pathological processes involving the wall of the bowel, and possibly by extrusion of weak parts of the wall without gross disease. In favour of extrusion from internal pressure as a cause of non-inflammatory pouches, Perry and Shaw point out that the duodenum is the only part of the small intestine in which ulcers produce pouches. They suggest that closure of the pylorus when the duodenum is contracting will cause a higher pressure than is likely to be produced elsewhere in the small intestine. Keith also urged that a region in which pouches are often found, namely, near the papilla of Vater, is a weak point in the musculature.

Others believe that the majority of the pouches are congenital, because they have many times been found when there was no evidence of inflammation, dilatation, or hypertrophy of the bowel near by; and chiefly on the inner concave aspect of the horseshoe-shaped duodenum, which is supported to some extent by the pancreas, and would, according to these writers, presumably be less liable to pressure extrusions than the convex aspect. Extrusion from internal pressure may reasonably be excluded in such a diverticulum as that mentioned by Grey Turner, in which the mucous membrane at the apex of the pouch was thrown into folds. The congenital origin of many such diverticula is also

supported by the considerations that they are frequently single ; that the development of the pancreas and liver in the embryo as outgrowths from the duodenum make the occurrence of other outgrowths not improbable ; that many duodenal diverticula have their distal pole lying close to or in the pancreas, and some are associated with accessory pancreatic tissue. Lastly, duodenal diverticula are sometimes found with other congenital anomalies such as congenital folds of the duodenum (Wilkie), Meckel's diverticulum, and diverticula of the œsophagus ; also with stenosis of the duodenum (E. Shaw). But generally it may be noted that in congenital stenosis of the small intestine, although the bowel above the obstruction is commonly dilated, pouching of this type is not usually recorded (N. I. Spriggs).

The fact that nearly all duodenal diverticula have been found post mortem in elderly people is an argument of weight in favour of the view that they are acquired and not congenital. But it must not be forgotten that most post-mortem examinations are of elderly people. Also congenital diverticula, which were at first small, may become larger and more obvious from dilatation as the years pass.

It appears likely, from recent post-mortem statistics, that duodenal pouches will be found oftener than hitherto if a careful search be made. They are easily overlooked at autopsy, and still more so on the operating table, as the aspect of the duodenum from which they arise is usually extraperitoneal.

The commonest situation is the second part of the duodenum. More than one diverticulum may be present, but, unlike the small colic diverticula, they are most frequently single, and to find more than two is rare.* Buschi mentions the site of forty-four cases. Adding to these the cases of Bauer, Wilkie, Basch, Ritchie and McWhorter, and Berblinger, we find, out of 57 cases, 11 in the first part, 2 in both first and second parts, 41 in the second part, and 3 only in the third.

The size varies from a linseed to a hen's egg (Buschi), and is usually about that of a walnut (Perry and Shaw). The mouth of the diverticulum is frequently wide, admitting a finger-tip or even the thumb. The structure is that of the duodenal mucous membrane, with the muscularis mucosæ, and frequently some fibres—often atrophic—from the outer muscular layers.

As a rule, duodenal diverticula are harmless, no doubt because they drain easily from the wide openings. The fact that their existence has generally been revealed accidentally after death bears witness to their innocent nature. Wilkie thought that, in two out of his three cases, stagnation in a diverticulum may have led to chronic duodenal catarrh. One case died of acute hæmorrhagic pancreatitis ; gall-stones were present. The other had duodenal ulcer, cholecystitis, gall-stones, and advanced cirrhosis of the liver. In that patient alcoholism, which presumably caused the cirrhosis, was also a likely cause for duodenal catarrh ; and in neither case was definite inflammation of the lining membrane of the sac, or clear evidence that a sac pressed on surrounding parts, noted. But in at least two published cases it seems clear that a non-inflammatory diverticulum gave rise to disease. In one (Bauer) a large diverticulum of the second part of the duodenum was thought, when filled, to have pulled on the pylorus and caused persistent vomiting. The patient became cachectic ; gastrojejunostomy was done, but he continued to vomit, and died eleven days later. Bauer published another case, which has been quoted by others, in which he attributed pathological consequences to a diverticulum ; but the original description is not convincing, as the patient, who was 80 years of age, died of hæmorrhage from a 'struma' in the chest.

The second case in which the evidence seems clear that a diverticulum caused symptoms is that of Basch. The patient complained of flatulence, 'sour stomach', and aching of the right upper quadrant of the abdomen, which came on an hour after food. A diagnosis

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* Multiple small acquired diverticula of the duodenum, jejunum, and ileum were found by Hansemann in a man of 85, in whom the multiple diverticula sometimes found in the large intestine in elderly people were also present.

was made, before *x*-ray examination, of chronic inflammatory disease in the duodenal region of the gall-bladder. A pouch was detected by *x* rays at the junction of the second and third parts of the duodenum. At operation the second part of the duodenum was dilated and hypertrophied, apparently from the efforts of the gut to force out the contents of the sac. The diverticulum was excised and gastrojejunostomy done. Basch suggests that some patients in whom a duodenal ulcer is expected but not found at operation, may have a duodenal diverticulum, which may easily be missed by the surgeon.

A brief description of the cases which came under our notice is now given.

DIVERTICULA OF THE SECOND PART OF THE DUODENUM.

Case 1.—No. 642. **Early Graves' disease.**

Male, age 55. (*Fig.* 12.) Barium was seen in a diverticulum of the second part of the duodenum.

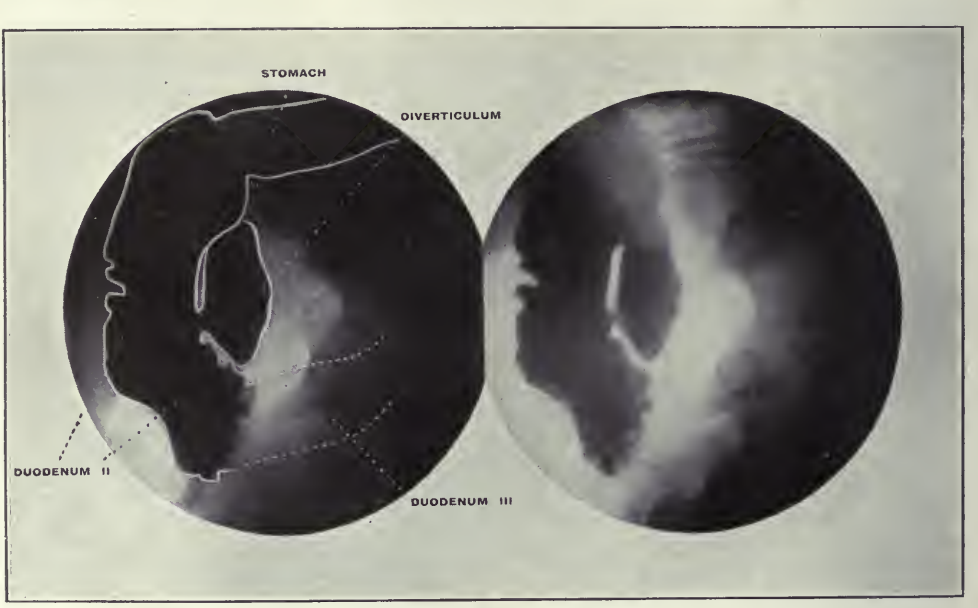

FIG. 12.—Early Graves' disease.

Case 2.—No. 880. **Nervous exhaustion and sleeplessness.**

Male, age 69. (*Fig.* 13.) Two gall-stones were removed twelve years before admission. A typical mushroom-shaped diverticulum was observed on the inner side of the second part of the duodenum, communicating by a wide mouth with the lumen.

Case 3.—No. 612. **Gastric and duodenal ulcer.**

Male, age 51. Gastro-enterostomy ten years ago. Recent hæmorrhage. Deformities of the pyloric part of the stomach and the first part of the duodenum were visible. The barium also entered a small rounded cavity on the inner side of the second part of the duodenum.

Case 4.—No. 529. **Hæmorrhoids and constipation.**

Female, age 72. (*Fig.* 14.) A small diverticulum in the second part of the duodenum. The duodenum above appeared to be held upwards and forwards by adhesions, and showed exaggerated activity at the early stages.

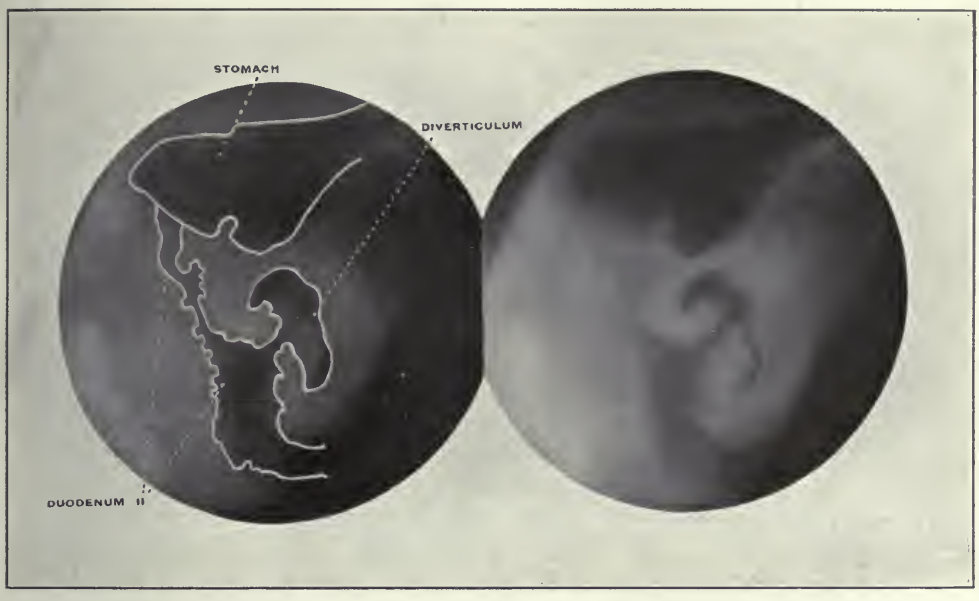

FIG. 13.—Nervous exhaustion and sleeplessness.

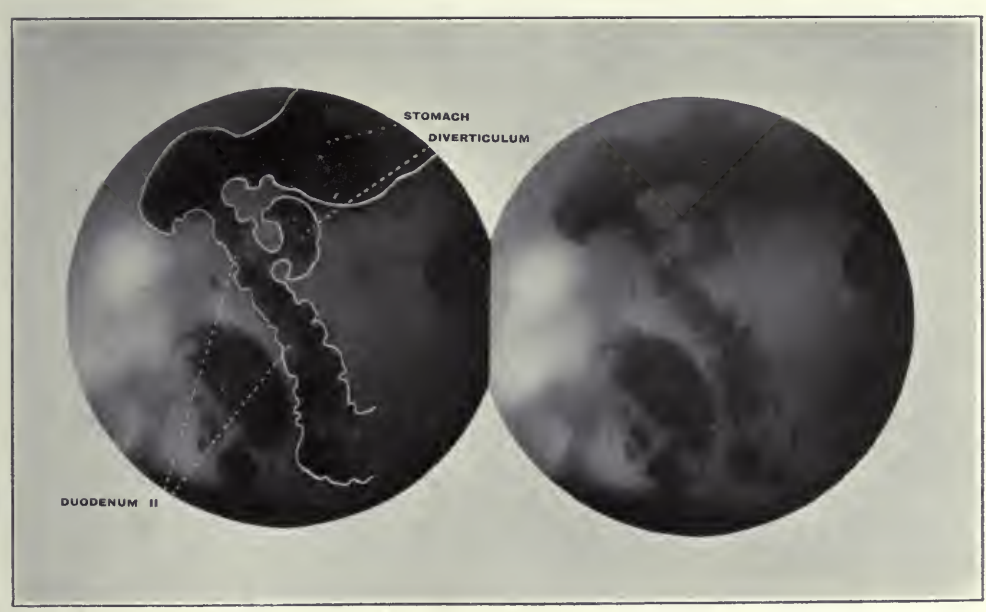

FIG. 14.—Hæmorrhoids and constipation.

Case 5.—No. 1424. **Hypochlorhydria (Achylia).**

Male, age 54. (*Fig.* 15.) Two diverticula, one large and one small, were seen on the inner side of the second part of the duodenum. They retained barium some hours after the stomach and duodenum were empty.

The patient complained of nausea, with occasional vomiting, and attacks of diarrhœa. He had brought up some blood three times in twenty-three years. The achylia was of a sufficiently severe degree to explain his present symptoms, and with treatment for that complaint they have now been relieved.

In this case the diverticula cannot be absolved from a share in causing symptoms. The patient is still under observation. Exploration will be advised if his progress is interrupted by recurrence of nausea or vomiting.

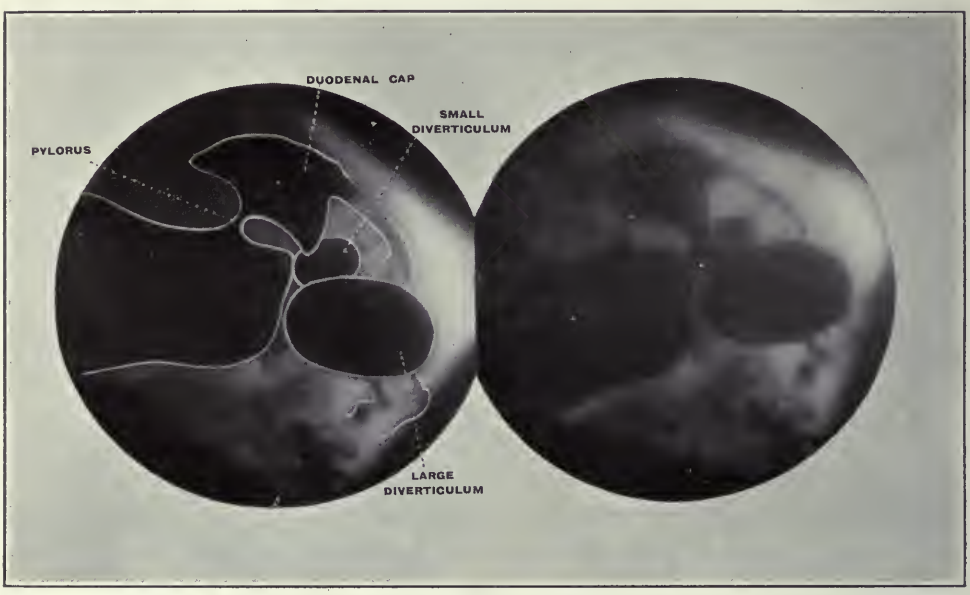

FIG. 15.—Hypochlorhydria (achylia).

Cases 1, 2, 3, and 5 were typical diverticula. In *Cases* 3 and 4 we connected the shadow at the time with the lesions of neighbouring parts of the duodenum, not being then aware that the neighbourhood of the ampulla of Vater is a favourite seat of these pouches. Cases are found in the literature in which diverticula of the non-inflammatory type and duodenal ulcers or gall-stones occur together; but a causal relation has not usually been established.

DIVERTICULA OF THE THIRD PART OF THE DUODENUM.

Case 6.—No. 696. **Irritable colon following repeated dysentery.**

Male, age 41. (*Fig.* 16.) The abdomen had been opened and the appendix removed. The patient says the surgeon told him there was no obstruction at the duodenojejunal flexure. *X* rays showed a large pouch in the third part of the duodenum projecting up into or in close connection with the pancreas. It had a definite neck, and was empty at seven hours after the opaque meal, two hours later than the stomach.

Case 7.—No. 996. **Large cystic right kidney.**

Female, age 53. (*Fig.* 17.) The duodenum was much displaced by the tumour. Its third part showed a large diverticulum with an indentation of its upper outline. The observation was verified at operation.

FIG. 16.—Irritable colon following repeated dysentery.

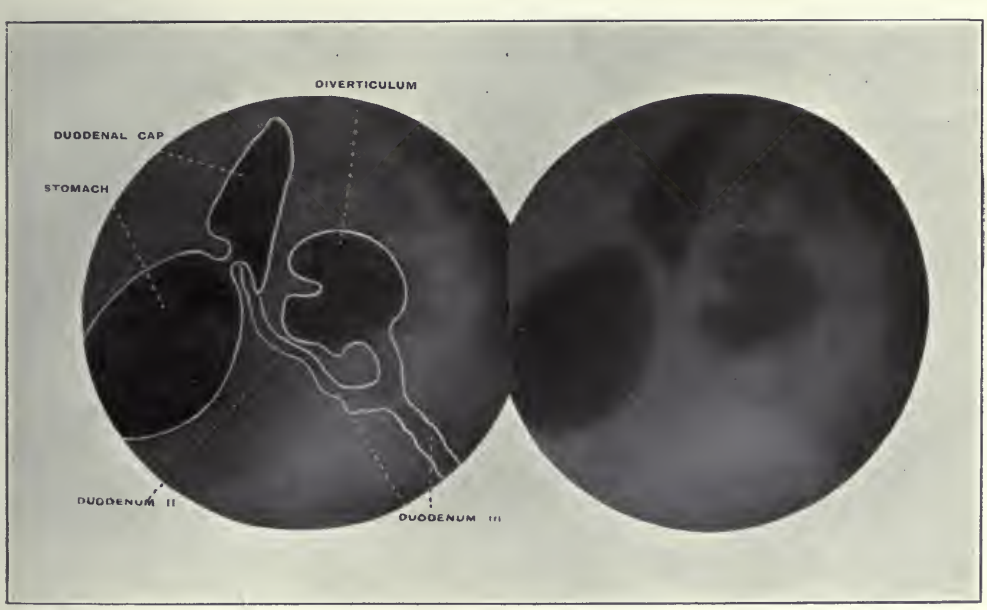

FIG. 17.—Large cystic right kidney

Case 8.—No. 1325. **Nervous exhaustion following overwork during the war.**

Male, age 53. (*Fig.* 18.) A large pouch was seen in the neighbourhood of the head of the pancreas. A channel could be followed between the pouch and the third part of the duodenum.

Case 9.—No. 795. **Chronic appendicitis (operation) and mitral regurgitation.**

Male, age 53. (*Fig.* 19.) A large single diverticulum was seen with *x* rays near the duodenojejunal flexure (in the modern nomenclature this would be reckoned as in the fourth part of the duodenum). It was not observed by the surgeon when he examined the duodenal region at operation. This patient was also the subject of a small diverticulum of the ileum, and small multiple diverticula of the colon. His case was one of those reported at the discussion on diverticulitis at the Royal Society of Medicine on Jan. 7 of this year.

Case 10.—No. 1245. **Gall-stone. Intestinal stasis. Hæmorrhoids.**

Female, age 44. A small single pouch was seen projecting from the upper border of the third part of the duodenum, in the region of the head of the pancreas.

Of these cases, five were in the second and five in the third part of the duodenum. Diverticula of the third or horizontal part of the duodenum are rare in the literature, only three cases being recorded by the authors referred to above.

Three of the patients with a pouch in the third part had had the abdomen opened, and in two of them the pouch had not been detected. In *Case* 6 the surgeon had specially examined the duodenojejunal flexure, close to the diverticulum, and had not seen it, probably because the pouch and its neck would lie entirely behind the peritoneum.

In nine of the ten cases the symptoms did not appear to be connected with the diverticulum, the diagnoses being Graves' disease, neurasthenia (2 cases), gastric and duodenal ulcer, hæmorrhoids, and constipation (2 cases, 1 also with a gall-stone), post-dysenteric colitis, cystic kidney, and chronic appendicitis.

In one patient (*Case* 5) it appears likely that the two diverticula present may be associated with the symptoms complained of. He is still under observation, and is improving with treatment for his hypochlorhydria.

Case 6, the subject of a huge cystic kidney, died after operation. The other patients recovered from their complaints and are well. Four of them are following active occupations.

In three other patients barium was noted to enter the ampulla of Vater, which was dilated and showed depressions, ascribed to biliary calculi, in the otherwise smoothly-outlined shadow in the ampullæ. These cases are of a different nature and are not included. In one of them the diagnosis has been verified by operation.

The shadows cast by opaque material in pouches may be puzzling when first observed. In *Case* 9 the shadow of the apex of the pouch projected behind and above the outline of the lesser border of the stomach in the erect position, simulating the appearance of the crater of an ulcer. If the pouch is filled, but not its neck, it is necessary to watch on the screen until a moment at which contents pass down the duodenum, in order to establish the relation of the bowel to the shadow.

SUMMARY.

1. Ten cases of single diverticulum of the duodenum, discovered in the course of over a thousand *x*-ray examinations of the alimentary tract, are reported, with radiographs.

2. Five were in the second and five in the third part of the duodenum.

3. One case was observed at operation. In two of the others the duodenum had been examined by a surgeon, but the diverticulum had not been detected.

4. The shadows of duodenal diverticula may cause confusion at the *x*-ray examination.

FIG. 18.—Nervous exhaustion following overwork during the war.

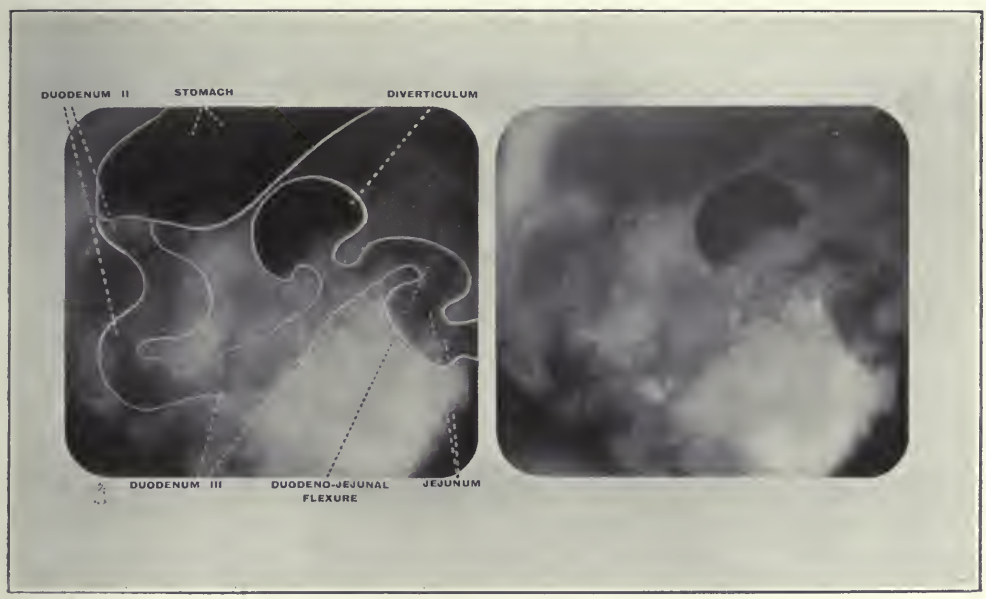

FIG. 19.—Chronic appendicitis and mitral regurgitation.

5. In nine of these cases the symptoms were not connected with the diverticula. In one case, still under observation, the point is doubtful. The literature shows that such diverticula have, though but rarely, been the cause of disease.

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THE RITUAL OF A SURGICAL OPERATION.*

By Sir BERKELEY G. A. MOYNIHAN.

Every operation in surgery is an experiment in bacteriology. The success of the experiment in respect of the salvation of the patient, the quality of healing in the wound, the amount of local or constitutional reaction, the discomforts during the days following operation, and the nature and severity of any possible sequels, depend not only on the skill but also upon the care exercised by the surgeon in the ritual of the operation. The 'ritualist' must not be a man unduly concerned with fixed forms and ceremonies, with carrying out the rigidly prescribed ordinances of the surgical sect to which he owes allegiance; but a man who, while observing with unfaltering loyalty those practices which experience and experiment have together imposed upon him, refuses to be merely a mimic bound by custom and routine. He must set endeavour in continual motion, and seek always and earnestly for simpler methods and a better way. In the craft of surgery the master word is simplicity.

The ritual of an operation commences before, sometimes long before, the incision is made, and may continue for a long period after the wound is healed. In the transition of a patient from ill health to sound health the operation itself is only one—though it may be the most important—of all the factors concerned in this fortunate event.

In this discussion we are not asked to deal with two essential preliminary propositions, the necessity for the most careful clinical inquiry into all aspects of the patient's history and condition, so that accuracy of diagnosis may be achieved before operation; and the exact relevance of the proposed operation in the particular conditions recognized by this inquiry, or discovered during the course of the operation itself. A great many mistakes are still made in both these matters. It is useless, to say the least, to perform the most perfect technical operation in conditions which do not call for it; and the test of a successful operation is not restricted to the healing of the wound, but to the ultimate effects of the procedure upon the disorder of the patient.

When conducting our experiment in bacteriology, we must recognize that micro-organisms capable of causing the direst disaster may possibly be everywhere—in the air, on the hands, instruments, gauze, catgut, etc., which may be introduced into the wound, or upon the surface of the patient's body. The possibility of the patient's own tissues furnishing a septic organism is so remote that we may leave it out of account entirely. It is an excuse to condone rather than a reason to explain the occurrence of infection.

Our bacteriological experiment may be conducted with one of two intentions: (1) The exclusion of all organisms from the wound; (2) The destruction of all organisms reaching the wound, by a bactericide applied to the wound surfaces.

It is not accurate to speak of these two methods as those of 'aseptic' and 'antiseptic' surgery; for to speak strictly there is no 'aseptic' surgery. In every operation some antiseptic is used on the surgeon's hands or the patient's skin. The terms are accurate enough if they are held to apply only to that part of the operation which begins with the incision of the skin. After this point the use of antiseptics in a 'clean' case is rarely necessary, is often undesirable, and is almost always of greater harm than benefit. It is to insult tissues and to doubt them, when it would be better to trust their very considerable powers of self-defence.

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* Remarks made at the opening of a discussion at the first meeting of the British Association of Surgeons, held at the Royal College of Surgeons, May 14, 1920.

In speaking of the results of an operation a surgeon may be a prejudiced witness as to his own efforts, and a bad judge of his own merit. When we speak, for example, of 'healing by first intention', what do we mean? What is our standard? Let us take extreme examples. In the one we mean a wound which heals within a few days, leaving a thin, straight, narrow line of palest pink. Around this line and the stitch-marks everything appears 'cold'. There is no redness, no swelling, no stiffness or induration, and at the line itself the most accurate apposition of skin edges is seen. There is no discharge from the wound. There has been neither local nor constitutional reaction following the operation. In the other, we mean a wound which is anything but straight; the edges are jagged, they do not meet accurately at every part, they overlap here and there; the line of healing is broad and irregular, raised and red, a stieky discharge oozes from the unapposed surfaces, and a scab may lie where this discharge has dried. The parts around are raised, tender, doughy, or stiff. The stitches seem to sink into the skin. You may see wounds of this kind in some clinics, and hear a complacent comment that the wound has healed by 'first intention'. Such wounds are the clearest evidences either of a bad technique or of a clumsy operator, or perhaps of both. If we had a Dr. Johnson in our profession, and he were asked his opinion of such wounds, what would he thunder in reply? We know what he said when pressed for his opinion of a young lady's verses. "Why, they are very well for a young miss's verses; that is to say, compared with excellence, nothing; but very well for the person who wrote them".

In every discussion it is necessary for the protagonists to agree as to definitions and the exact meaning to be attached to words; otherwise polemics are valueless. We must here discriminate between 'perfect' and 'imperfect' healing, though both may be classed as examples of healing by 'first intention'. It is, moreover, not only a question of the healing of the superficial, visible wound which is our concern. With the two types of wound healing I have described there are associated, not only the varying chances of life or death, but also two types of convalescence, especially in abdominal cases. In the former the patient suffers hardly at all, indeed, as a rule, not at all, unless there have been great technical difficulties in the operation itself, such as remoteness of the parts concerned in a very stout subject.

For example may be quoted an operation for cholelithiasis, in a very fat woman, when the liver lies high, and the gall-bladder is small, bound up in dense adhesions, fixed to the duodenum (perhaps with a fistula into it) and the back of the abdomen. The liver and costal margin may need to be held up, and the abdominal viscera to be dragged downwards, before the sclerosed gall-bladder or a dilated common duct containing a stone can be seen. I know nothing in surgery which approaches such cases in difficulty, or which requires such care, gentleness, patience, and skill on the part of a surgeon. I sometimes hear the operation for the removal of a Gasserian ganglion or the avulsion of its sensory root spoken of as 'difficult'. It is work for a novice compared with that in many a gall-bladder case. Apart from cases such as these, which require firm handling, the amount of reaction is negligible. More than half the abdominal cases, except for a little flatulence, hardly realize that they have had an operation performed. Flatulence is a troublesome complication, not only of abdominal, but of other operations also. Its cause is uncertain. My own view is that it chiefly results from the starvation and purgation which are almost universally considered a necessary part of the ritual of deliberate operations. Both are certainly undesirable, and are possibly harmful. Solid food is much like liquid food by the time it gets well on its way in the jejunum. As much fluid as the patient wishes to have should be allowed to within an hour or two of the time arranged for any operation, and as soon as possible afterwards. Operations on the stomach are no exception. An enema generally clears the colon quite as much as is necessary. Aperients increase the number and the virulence of the intestinal miero-organisms, and are apt to deprive the patient of large amounts of fluid and to cause exhaustion: effects which are all most undesirable.

With the kind of wound just described there is a far greater general reaction and a higher degree of discomfort or of pain, and there is a greater likelihood of complications,

grave or trivial, such as phlebitis, thrombosis, the late discharge of buried ligatures or sutures, or the recurrence of the condition which originally required operation.

Surgery should be a merciful art. The cleaner and the gentler the act of operation, the less the patient suffers, the smoother and the quicker his convalescence, the more exquisite his healed wound, and the happier his memory of the whole incident, to him probably one of the most important in his life. The results of our ritual are therefore expressed not only in the mortality—where the difference may be slight—but also in the quality of the healing of the wound, and in the quality of the recovery from the operation, in respect of security, rapidity, smoothness, completeness, and finality.

In the ritual of a surgical operation the mysteries are imposed not only upon the high priest and upon the acolytes, but upon the congregation also. Every visitor to an operation theatre takes a part, however remote, in the operation. He is gowned, masked, and his head covered with a cap nowadays in all clinics. But dirty boots and soiled trouser legs, conveying mud, dust, and fæcal matter from the streets, are often unnoticed. If the wearer of them moves about the theatre freely, or goes from one theatre to another, the organisms carried in the drying filth are scattered broadcast, as the simplest experiment will prove. Large canvas overalls for the boots and the lower part of the leg, tying just below the knee, as a sort of legging, will afford ample and secure covering to this possible source of infection.

The surgeon and his assistants (the fewer the better) should of course change all their external garments before operation. The trousers and coats we all wear are very dirty. What would a pair of tennis flannels look like at the end of a week's wear in London ? Our everyday darker garments do not show the same marks, but they carry the same dirt. White sterilized trousers, clean white shoes, or overshoes, sterile coat, cap and mask, all are necessary for the perfect outfit. They are much more comfortable to wear in a theatre adequately warmed, and there is a feeling of much greater freshness, both before and after an operation, when garments are changed. But I am, no doubt, like Jonah preaching to a converted Nineveh. All these matters are now a part of our daily routine.

The method of the preparation of our hands and arms is important. It is still a common thing to see hands washed in a basin of still water. The moment the hands are soaped and rinsed the water is polluted by the dirt washed off the skin. If the washing is continued it is obvious that the hands are being constantly re-infected from the contaminated water. If the water is emptied away, and fresh poured in, the basin, being polluted by the water it formerly contained, defiles the fresh water. And it is really not uncommon to see a piece of soap used to lather the hands, laid down, and picked up again, regardless of the fact that each contact of the soap with something else is a possible method of soiling it. The best of all plans is to wash under running sterile water. Some years ago I had water-tanks made, to hold five or six gallons, fitted with a dispensary tap, and placed over gas-coils, so that the water contained in them might be boiled. When the water boils the tap is turned, and about a gallon of water allowed to run through to sterilize the tap, on the end of which a boiled plug is fitted until the time comes for use. In a hospital installation it is easy to arrange for the tanks to be sterilized by steam and to be cooled by water running through a coiled pipe in the tank. Water can be boiled for a quarter of an hour, and cooled sufficiently for use in five minutes. Over the tank is placed a tap for refilling.

Almost all commercial soaps are sterile. The outer surface of course may be polluted, but when this is washed or scraped away the exposed fresh surface of the soap is sterile. Two methods of using soap are simple and satisfactory : to use a tablet of any household soap which has been lying in a solution of acrosyl for half an hour ; or to sterilize some green soft soap in a flat dish in the autoclave, and to rub off, time after time, with a sterile gauze swab, enough of the soap to form a good lather. After washing for not less than fifteen minutes, the hands should be gently rubbed with gauze wet in spirit and biniodide solution, or in a solution of acrosyl, which is the antiseptic least likely to damage the skin. There is a great difference in the facility with which a hand can be cleaned ; some rough chapped hands, coarsened by antiseptics, clean with great difficulty ; smooth hands, well cared for, are sterile very soon. A surgeon's hand should be always carefully tended ;

nails should be kept clean and short and smooth, and the skin like satin. Once a week or so a visit to a manicurist is desirable.

Gloves are almost universally worn during operations. I know only three surgeons the world over who are in the first rank who do not constantly wear gloves during operations. The arguments in favour of their use are unanswerable. A glove properly prepared is sterile, and remains so if put on the hand without its outer side being touched by anything except the glove of the other hand or a piece of sterile gauze. With practice it is rare to puncture a glove except in bone operations, and for these it is often an advantage to wear thin cotton gloves over the rubber. If a puncture does occur, a finger stall may be put on, or the glove changed in a few seconds. The bare hand is difficult to sterilize in some cases; it is almost impossible to keep it sterile throughout an operation, as the silk-thread experiment of Kocher shows; if it is infected during an operation it can certainly not be used uncovered again with safety during that operation.

A surgeon may say that he uses gloves only for septic cases. Does he always know when an operation, or any stage in it, is to be septic? If he inadvertently soils his hand when a septic area is unexpectedly discovered, does he then put on gloves? Has he them always ready to wear? Or does he use an antiseptic in the hope of combating the infection which he spreads with every touch? Is not the simpler, safer, more certain way to wear gloves which are certainly sterile, and to change them when there is any doubt as to their defilement?

But about the wearing of gloves a good deal may be said. Often they are a mere fetish. How often are gloves put on without their outer surfaces being touched, or stroked by a bare hand? How often are they considered rather a protection for the surgeon than for the patient? I have seen gloves put on carefully, and the gloved hand then used to palpate an abdomen imperfectly smeared with iodine. I have seen a blanket which covered a patient's legs pulled up towards his body by a gloved hand which a few minutes later was inside the patient's abdominal cavity; and I have seen cleaned hands gloved, and unclean forearms left bare, on more than one occasion. I have seen gloves used in the earlier stages of operation, and removed when a difficulty arose in, say, an operation upon an enlarged thyroid gland, or an operation for hernia. This is a technical sin of the gravest kind. Gloves may be sterilized by boiling, or be placed in the autoclave with the dressings and swabs and used dry. The advantage of the dry glove is that it is more comfortable to wear during a long list of operations, and that the hand being covered by a dry sterile powder is kept free from moisture. A chance puncture of the glove does not involve the escape of a possibly contaminated fluid into the wound. Gloves should be kept on the hands till the dressing of the wound is complete, and until the coat and sleeves are removed. If gloves are properly sterilized and properly put on, the covered finger may be used to explore a knee-joint or anywhere else with impunity.

The 'knife-and-fork' method of operating, in which only instruments are handled for every purpose, including the tying of ligatures, is a confession that the gloves cannot be trusted by the operator. If the bare hand is used during operations there is a risk which approaches certainty that the wound will be contaminated. This contamination may be lessened in its malignancy by the immediate application of antiseptics, or by the free and frequent washing of the hands in a bactericidal solution; but the results either of mild contamination or of the irritation of antiseptics in the wound are expressed in those qualities of its healing to which I have referred. Many years ago, before I began to use 'tetra' cloths to cover the skin around the wound up to its edges, we found that when cultures were taken from a wound they became progressively more numerous the longer the incision remained open; but many an infected wound healed by what we were then content to call 'first intention'. We soon learnt that there was a degree of 'clinical sterility' of a wound which was far removed from the 'absolute sterility' which it should be our endeavour always to secure, and which alone allows of 'perfect' flawless healing and a convalescence free from suffering. Above the gloves worn by all those directly engaged in the operation no bare arm should be seen. Either a long-sleeved gown should be worn, or sleeves which fit firmly round the wrist, there to be covered by the cuff of the glove.

Among the more important questions involved in the ritual of a surgical operation is that concerned with the preparation of the skin. The skin does not always, indeed does not often, harbour organisms, either on the surface or in the depths of sweat or sebaceous glands, of any special septic malignancy; but one can never be certain to what contact the skin has been subject, and therefore it is always uncertain whether septic organisms or spore-bearing bacilli are present or not. It is always necessary so to prepare the skin for a wide area around the wound to be inflicted that, so far as is humanly possible, no contamination of the wound shall be caused from this source. Infection may be conveyed to the skin of the surgeon's hands by the examination of discharging wounds, by rectal or vaginal or buccal examinations, or during an operation. This possibility should be prevented by the avoidance of any contact with patients, in these circumstances, unless gloves are worn. The principal of 'abstinence' is the safest: the surgeon abstains from soiling his hands by contact with any potentially infective agent.

It is exceedingly difficult so to sterilize the human skin that it will long remain sterile, as all the experiments conducted in recent years have shown. When a germicidal solution is applied to the skin, there is a 'clean fight', so to speak, between the solution and the germs lying in or on the skin. The value of the solution as a germicide is therefore easy to test, and results obtained by these experiments may be accepted as of great value. It is far otherwise when a germicidal solution is applied to a wound, especially to an open wound a few days old, wherein reparative processes have begun. In such a wound an innumerable number of side contests are introduced; it is no longer a fight between a germ and a germicide. There are the cellular and the fluid contents of the wound discharge, and the various actions and reactions produced among them, the wound surfaces, the dressings, and the germicide all to be taken into account. It is a matter of interest to consider whether we do not go far astray when we assess the value of a germicide in an experiment *in vitro*, and then expect an equivalent germicidal action to be produced in an open wound. It is, I think, very doubtful whether the 'antiseptic' action produced by the addition of a particular chemical substance to a wound is due to those properties which it possesses as a bactericide. It probably possesses other properties also which are not strictly related to its germicidal power. But in the case of the skin no such perplexing problems arise. The efficacy of any germicide can be tested quite easily; and the results of experiments should here guide our practice. A surgeon may say that he is satisfied with the healing of his wounds when he might quite easily have better results by using better methods of skin sterilization. By clinical experience, which is tedious and lengthy, we may at last realize the value of skin disinfection, which we might have determined at once by experiment. By experience we find a short way by a long wandering.

What are the requirements for an ideal skin disinfectant? It should be cheap and easily accessible, simple in its application, non-irritant, capable of penetrating the skin to some depth; it should be effective in destroying in a short time all of the organisms which are found on or in the skin, and it should do nothing to prevent or delay the clean and speedy healing of the wound.

The skin disinfectant most commonly employed is iodine. It is applied in varying strengths, and in different vehicles—spirit, chloroform, acetone, benzine, etc. The tincture of iodine is the form which is most often used. Both experimentally and clinically the method is clearly of the second rate. The work of Tinker and Prince, Hunter Robb, Stanton, and others, shows that even when the iodine is allowed to remain on the skin which is tested, sterilization is not always indicated by the culture tube; if the iodine is removed by a solution of potassium iodide, and the skin washed with sterile water and examined, infection is demonstrable in over 50 per cent of cases. A very large proportion of the iodine used often disappears from the skin before the operation is completed. There is nothing then to recommend iodine but the ease and rapidity with which it can be applied and its colouring of the skin; its efficacy is far less than is required, and it is a powerful irritant. Iodine, to be effective, must be applied on a dry skin, which often means a dirty skin. I have more than once seen a smear of iodine applied over grime and filth that could not be sterilized by a dozen similar applications. I have used iodine myself on a great

many occasions, and have given it a fair trial; I have seen it in a very large number of clinics; yet I have very rarely seen a wound heal with all those attributes which are necessary before one is entitled to say that it is 'perfect', when iodine alone has been applied. Picric acid in alcoholic solution of a 3 per cent or 5 per cent strength gives better results than iodine; but it does not penetrate deeply, and it is not of sufficient bactericidal value. The wounds are, again, not up to the highest standard in a large number of cases.

By far the best method of preparing the skin that I have ever used—and I have tried and tested many—is carried out in three stages: (1) Abundant washing with soap and water, preferably ether soap; (2) Gentle friction with biniodide of mercury and spirit solution 1–500; (3) Drying; followed by the application for two to three minutes of Harrington's solution. When the towels are fixed round the operation area a further application of Harrington's solution is made; and throughout all operations the skin is covered with towels so that no friction of the hands against it is possible. It would be well if surgeons the world over took a little more pride in the wounds they inflict. The appearance of a wound is often the best index to the quality of the work that has been done throughout the operation.

The towels, which should surround the operation area as closely as possible, are fixed to the skin by clips. On the surface of the skin left exposed, a series of tiny scratches are made by a very thin needle, at right angles to the proposed line of incision. These are for the purpose of indicating where the stitches are to be introduced when the wound is sutured. Unless there is a mathematical accuracy of apposition there is never perfect beauty in a wound or scar, and accuracy of apposition is difficult or impossible unless some method of this kind is adopted to secure it.

In so far as the actual operation is concerned, it is, for the reasons I have given, essential to avoid contact with the skin of a patient as much as possible. The hands should not touch the skin at all, viscera should not be allowed to lie upon it, and the rubbing of instruments against it must be avoided. As soon as the incision is made, cloths of several thicknesses of gauze or towelling are fixed to the skin edges and dip well into the wound. If these 'tetra' cloths lie loosely on the parts around the wound, they ruffle up during the movements of the surgeon's hands. If powder is dusted on the under surface of them it is soon found to lie in the wound. The towels must therefore be held at points distant from the wound, so that they are kept stretched and fixed throughout the operation. When they are removed at the conclusion of the operation, the skin covered by them is washed over with spirit and with Harrington's solution before any stitches are inserted.

The wound is made by a firm, clean sweep of the knife. Any bungling here makes an irregular, ugly wound. A good many of the scalpels made nowadays are peculiarly unfitted for their work. I use only two patterns: one with a deep belly, made for me by Stille of Stockholm originally, and the other Stiles's pattern, which is used for all dissections. All vessels are clipped if possible, as in a hernia operation, before being cut, but certainly the moment they are cut. If blood leaks into a wound it stains the tissues, and makes subsequent dissection along the 'white line' very difficult.

I say that 'vessels' are clipped. Most of the clips made seize not only the vessels but a mass of tissue surrounding them. When ligatures are applied, all this tissue is strangled in the ligature, and has to be digested by leucocytes in the wound. The tips of artery clips should be narrow—almost pointed—and should seize the very smallest possible portion of tissue with the vessel. If dissection is carried on in a wound, as when glands of the neck, or of the breast in a case of carcinoma, are removed, gentle traction in one direction by the surgeon, and in the opposite by his assistant, will reveal a fluffy layer of thin areolar tissue, the 'white line' as I always call it, along which dissection can proceed very easily and quickly, and with the immediate disclosure of all the vessels which must be seized. This involves the application of many clips, but the wound should always be kept dry and unstained by blood. Kocher was accustomed to put out twenty dozen clips for a goitre operation, and on many occasions he seemed to use most of them. It

should be our ideal to complete such an operation, which in my student days was often one involving much loss of blood, without staining the towels round the wound.

Though traction is necessary in gland and goitre operations, it must be avoided in abdominal work. There every pull means a pain. I dislike abdominal retractors intensely. The forcible and merciless retraction of the abdominal wall throughout a long operation cannot fail to cause shock and suffering afterwards. The best retractor is the gentle light hand of a well-trained assistant, used mercifully when it must be used at all. But with adequate incisions, retraction is very little needed during the greater part of most operations.

Dissection may be carried out in two manners: by the knife, or by 'gauze stripping'. If by the knife, the movements should be short, sharp, close together, so that if recorded on a moving drum the picture would resemble a 'feather edge'. And the knife must be sharp. Big, heavy, clumsy movements with a dull knife hurt the patient, and leave the parts less fitted to heal. Throughout the operation there must be no undue exposure of parts. In a large dissection, such as that required in removal of a cancer of the breast, the dissection extends from the axilla to the umbilicus, and from the opposite pectoral muscle over the latissimus dorsi. With skin flaps turned back, the bared area is very extensive. It should never be seen as a whole. As one part of the dissection is completed, hot moist mackintosh cloths are placed over the raw surface to prevent drying and chilling, and the chance of contamination. Similarly, in abdominal work, only that part of the operation field should be seen with which the operator is at the moment engaged. There is no need in the operation of gastro-enterostomy, for example, for anything to be outside the abdomen during the suturing of the viscera except that small part of each which is embraced by the clamps. The patient is accustomed to keep his own viscera warm, and he should still be allowed to do so. Crile's work has shown, to my mind conclusively, the need for avoiding cooling or drying of wound surfaces.

All the instruments used during the operation are of course sterilized by heat; but it is important to remember that contamination may occur during an operation, and therefore the various clips, scissors, retractors, or other instruments should be re-sterilized as often as is necessary. If, for example, a pair of scissors are used to open the intestine in a case of gastro-enterostomy or colectomy, or needles to suture viscera together, they are at once discarded, and never used again till they have been boiled. The mucosa may be sterile in a case of gastro-enterostomy, but one can never be certain, and it is safer always to assume that any possibly infected tissue *is* infected.

In operations for malignant disease, frequent sterilization of instruments is most necessary. For example, in removing a breast for carcinoma, many surgeons, of whom I am one, adopt the method suggested by Rodman and Willy Meyer, and complete the axillary dissections first. There are many advantages in so doing which need no mention now. Every instrument used in this dissection—knife, clips, scissors—may possibly be brought into contact with a cancer cell. When once used it is therefore laid aside, and not taken up again till it has been re-boiled. Cancer cells, as Ryall and others have shown, can be grafted on to the patient's own tissues and develop a new deposit of cancer. It is obvious that the graft may be conveyed on any instrument, or on the gloved hand if it is at work in the wound. In all operations I have a red handkerchief placed on the table which lies over the legs of the patient. As soon as any instrument is soiled I place it on this danger spot, and it is at once removed by the nurse to the sterilizer.

As regards the material used for ligatures and sutures which must remain within the wound, certain conditions are essential. Such material should, ideally: (1) Achieve its purpose—be sufficient to hold parts together, close a vessel, etc.; (2) Disappear as soon as its work is accomplished; (3) Be free from infection; and (4) Be non-irritant.

The only material which can be made to fulfil these conditions is catgut. Catgut can be sterilized perfectly. The method of Claudius, which directs that the catgut should be soaked in a solution consisting of iodine 1 per cent and potassium iodide 1 per cent in water, ignores the fact that with such a proportion of iodide of potassium all the iodine is not dissolved; much of it lies inert at the bottom of the vessel. I use a solution made

in accordance with their atomic weights, iodine in a strength of 1 per cent and iodide of potassium in a strength of 1·75 per cent; the whole of the iodine is then taken up, a darker and stronger solution results, and catgut soaked in this for ten days or more is almost black in colour, and so strongly permeated by iodine that it is exceedingly difficult to infect it. I have never known any surgeon use silk and not have trouble from it. Silk for ligatures is not necessary, for catgut will securely tie any vessel. Silk for intestinal sutures is not necessary. Certainly I have not used any for fifteen years, and I have now discarded linen thread for all but the anastomoses after colectomy. An unabsorbable suture used to effect the junction in gastro-enterostomy is possibly a factor causing the development of a jejunal ulcer. But thick chromic catgut also will remain for years at a suture line in such a case. In one patient I have found a piece of chromic catgut over two inches long dangling at the gastrojejunal opening three years and nine months after the anastomosis had been made. It is of, course, as I have before pointed out, the sero-serous suture which is the offender in such instances. The inner mucous suture, no matter of what material, is soon loosened and escapes.

Probably we all use more sutures than are necessary in intestinal anastomoses. In urgent cases I have more than once used a single Connell suture with perfect success. But in surgery, in order to be certain that you have done enough, it is generally prudent to do more than is necessary. Over and over again I put in an additional stitch here and there. I know it is not really needed, but I call it my 'hypnotic' stitch; for I sleep better at night when I know it is there.

The most important person present at an operation is the patient. This is a truth not everywhere and always remembered. It is our duty to make the operation as little disagreeable as possible for him. To many patients it is a dreaded ordeal. Our patients to-day are terrified by the tradition that clings to the word 'operation', a tradition started in the days when it must indeed have been a terrible procedure, without anæsthetics other than those stupefying drugs, alcohol and tobacco, with patients strapped down or held by assistants, and all the other horrible accessories. To-day an operation can, and should, be made a very simple matter, devoid entirely of anything repellent or disheartening.

The preliminary use of scopolamine, atropine, and morphine, or of omnopon, is a very valuable help. One dose of $\frac{1}{120}$ gr. atropine and about $\frac{1}{100}$ or $\frac{1}{150}$ gr. scopolamine and $\frac{1}{6}$ or $\frac{1}{4}$ gr. morphine is needed, according to the patient's age, size, etc. This is given about three-quarters of an hour before operation. In a private hospital the blinds should then be drawn down, the room darkened, and the patient encouraged to sleep. No talking is allowed. The nurse remains in the room, but is warned not to speak, and of course no friends are then permitted to see the patient. When the patient is taken to the operation theatre as quietly as possible, a towel covers the eyes and the operation room itself is dark. No conversation is allowed in the theatre, and only the anæsthetist and one nurse, or possibly two nurses, remain. Everything is kept as quiet and orderly as possible. About one-third of the patients subsequently say they have little or no recollection of going to the theatre or of taking the anæsthetic. All abdominal cases are treated by Crile's method of quinine and urea injections into the parietal peritoneum, and into the nerve-trunks running to the area in which the operation takes place. There is no doubt as to the diminution of pain thereby resulting. With shock we are not much concerned. There are very few occasions indeed when shock results from an abdominal operation properly conducted, when the patient is kept warm on the table by one device or another, and when the gentlest handling, the most careful hæmostasis, and adequate protection of parts have been exercised.

Every detail in every operation is of importance, and should be conceived, practised, and tested with unwearying patience by the operator himself, and by him in conjunction with all his assistants. Was it not Michael Angelo who first said that success depends upon details, but success is no detail? In surgery, at least, success may well depend upon the scrupulous, exacting, and unceasing supervision and close scrutiny of every smallest incident of procedure. In respect of surgical work there may be some truth in

Blake's assertion that all excellence is in minute particulars. Surgery is nowadays no longer the work of an individual, but of a 'team' in which every member plays his exact part, in which all contribute to success, and in which each may bring about disaster. The well-trained team should display that mastery which is implied by ease in smooth and efficient action. In every phase of its work there should be, not merely the casual observance of a ritual the meaning of which is lost and the deeds of which are only a faded counterfeit, but acts of full devotion to principles which have been tried and proved, acts which are the witnesses to a living and perfect faith.

It is of course a platitude to say that a good surgeon is not merely one who operates well. The qualities required to make our ideal surgeon are many: gifts of character, leadership, wisdom—even worldly wisdom—compassion, and the finest technical skill. In respect of the latter we remember that surgery is not only a science but an art, work demanding the highest craftsmanship, and a knowledge of all the "tricks of the tools' true play".

In all the movements of the surgeon there should be neither haste nor waste. It matters less how quickly an operation is done than how accurately it is done. Speed should result from the method and the practised facility of the operator, and should not be his first and formal intention. It should be an accomplishment, not an aim. And every movement should tell, every action should achieve something. A manipulation, if it requires to be carried out, should not be half done and hesitatingly done. It should be deliberate, firm, intentional, and final. Infinite gentleness, scrupulous care, light handling, and purposeful, effective, quiet movements which are no more than a caress, are all necessary if an operation is to be the work of an artist, and not merely of a hewer of flesh. For every operation, even those procedures which are now quite commonplace, should be executed not in the spirit of an artisan who has a job to get through, but in the spirit of an artist who has something to interpret or create. An operation should not only bring relief or health to the patient, but should give a glow of keen delight to the artist himself, a thrill of joy and a sense of complete satisfaction to a critical spectator.

Ours has been a necessary profession ever since man's body was subject to enmity and casualty. All who practise it will need the gifts of which Thomas Fuller spoke—"an Eagle's eye, a Lady's hand, and a Lion's heart". Of all of us who labour honestly may it at last truthfully be said, as it was said of James IV of Scotland, "Quod vulnera scientissime tractaret"—"He was most skilful at the handling of wounds."

THE RÔLE OF RADIUM IN THE TREATMENT OF MALIGNANT DISEASE OF THE BLADDER AND MALE GENITAL ORGANS.

By CLIFFORD MORSON, London.

The progress made in this country during the last decade in the knowledge of the effect of radium upon human cells, normal and pathological, is not fully realized by the generality of the medical profession. Facts are gradually becoming known which in the near future will improve the technique of the treatment of malignant growths by radium, and in consequence yield better results than those which have been previously attained. While discussing the employment of radium in the treatment of cancer of the bladder and male genital organs, it should be borne in mind that the principles which apply to the treatment of growths in these organs apply equally elsewhere.

Effects of Radium upon Normal Tissues.—Definite degenerative changes are produced in the cells of the normal tissues of the mucous membrane and skin when exposed to radium irradiation. When a malignant growth of the mucous membrane of the mouth is exposed to the rays, their influence upon the normal mucous membrane will be apparent. The writer has studied these changes macroscopically and microscopically. The naked-eye appearance is instructive ; the pinkish colour of the mucous membrane is replaced by a grey hue, not unlike that seen in the early stages of leucoplakia of the vulva or anus. Gradually a film of this grey colour forms, which finally separates from the underlying tissues, leaving a shallow ulcer. The latter is tender, painful, and heals slowly. Microscopic examination of the film reveals the superficial cells of the mucous membrane undergoing keratinization. The process is similar to the changes seen in the early stages of leucoplakia, which latter is well known as a pre-cancerous condition. With regard to the effect of radium upon the skin, Becquerel and others experimented upon themselves, and produced an inflammatory condition, followed by ulceration. Five years ago the writer had personal experience of exposure to the gamma rays. As a result of handling radium daily over a period of two months, changes occurred in the skin of the forefinger and thumb of the right hand, causing a temporary loss of tactile sensation, with marked sensibility to heat and cold. Further reference will be made to the damage to normal tissues when describing the application of radium to growths of the bladder and prostate.

Sepsis in Relation to Radium Irradiation.—When this serious complication arises, the natural resistance of the patient disappears and the spread of the disease is rapid. Clinical experience demonstrates that the sensitiveness of the malignant cell on exposure to the rays is in direct proportion to the activity of its reproductive power. It might, therefore, be argued that the introduction of sepsis would favour the rapid destruction of the malignant cell when exposed to irradiation. However, the contrary occurs. Bacteria, when exposed to the gamma rays of radium—and it is the gamma radiation which is used chiefly for therapeutic purposes—are not destroyed unless the exposure be very prolonged. Strassmann performed numerous experiments in 1904 which showed that streptococci could only be killed by 10 mgrms. of radium with exposure of twenty-four hours, the screen used being mica. With a screen of mica and glass the exposure needed was thirty-six hours. In his experiments the beta rays were used as well as the gamma. Experiments by Russ and Chambers,[1] on lines somewhat different from those adopted by Strassmann, confirm the latter's observations. In 1914, with the assistance of Sidney Russ, the writer attempted to cure gonococcal urethritis by means of an active wire of platinum. The dose was equivalent to about 10 mgrms. of the radium salt ; the mucous membrane of the urethra was exposed to the alpha, beta, and gamma rays for about a

quarter of an hour. Not only did such treatment fail to destroy the gonococci, but the inflammatory reaction in the mucous membrane was so severe that further experiments on these lines were inevitably abandoned.

Let us turn to the data collected on the effect of radium upon leucocytes, the most efficient constituent of the blood in fighting bacteria.

Russ and Chambers[1] measured the phagocytic power of the leucocyte in a specimen of blood, and then at various times after exposure had begun to a concentration of 1·6 millieuries per c.c. The results obtained showed that an eight-hour exposure reduced phagocytosis by 46 per cent. Prolonged exposure led to the complete disintegration of the leucocytes. Of the different varieties of leucocytes, the lymphocytes were the most sensitive and therefore the most readily destroyed. Thus the phagocytic power of the leucocyte when exposed to the gamma rays of radium is gradually reduced, and prolonged exposure leads to its complete disintegration.

These experiments indicate that, when radium is used clinically, a large dose with prolonged exposure must be employed to remove organisms from a septic growth. But while this lethal dose is being applied, the rays are slowly undermining the power of the leucocyte to deal effectively with the invading bacteria. Thus the action of radium in destroying bacteria is neutralized by the harm it does to the leucocyte. Moreover, the danger of severely damaging the normal tissues around the tumour by such a large dose is not inconsiderable. The writer's clinical experience is that the spread of a growth is hastened by radium irradiation if sepsis is introduced.

MALIGNANT GROWTHS OF THE BLADDER.

There are four different methods whereby radium can be employed in the treatment of such growths. These are as follows: (1) *Surface application;* (2) *Internal application;* (3) *Combined surface and internal application;* (4) *Burying of radium in growth.*

1. **Surface Applications.**—Radium, put up in plates, is applied to the skin of the suprapubic region. Thus a considerable thickness of normal tissue intervenes between the radium and the growth. The main criticism of this procedure is that, apart from the danger of producing degenerative changes in these tissues, the greatest intensity of irradiation falls, not upon the growth, but upon the skin and underlying structures of the anterior abdominal wall.

2. **Internal Application.**—

a. A suprapubic cystotomy is performed and the radium dropped into the bladder cavity, where it must come in contact with the normal mucous membrane.[2] As at least an eight-hour exposure is necessary to destroy the malignant cell, it will be obvious that the changes in normal mucous membrane, described previously, will occur.

b. The radium is passed per urethram and placed broadside on the tumour by means of a special instrument devised by H. H. Young and W. A. Frontz, of Baltimore.[3] This instrument is tubular, and an observation cystoscope can be passed through it, enabling the operator to apply the radium accurately. But, apart from the damage to normal tissue, there is the discomfort of keeping a metal instrument in the urethra for eight consecutive hours.

3. **Combined Application.**—Radium is inserted into the rectum, and as far as possible kept in contact with its anterior wall in the region of the base of the bladder. At the same time radium is applied to the skin of the suprapubic region.

This method is to be deprecated on account of the reaction produced in the mucous membrane of the rectum. Pain and tenesmus follow the introduction of radium into the bowel, and cause great distress to the patient. Even Young, who advocates this method, admits its dangers; but he claims that these sequelæ can be avoided if the dose is carefully regulated and not frequently applied to any one spot.[3]

4. **Burying of Radium in Growth.**—A suprapubic cystotomy is performed and the radium buried in the substance of the tumour. The pioneer of this mode of exposing malignant cells to irradiation was Dominici, of Paris, whose untimely death must be a

cause of deep regret to those who wish to see radium therapy placed on a more scientific basis. The writer has adopted this method as giving the best results in the treatment of malignant disease of the bladder and male genital organs. It is important that the suprapubic cystotomy should be performed as early as possible, and the growth thoroughly irrigated with antiseptics twice daily for a week. Sanitas, one drachm to the pint, is non-irritating and yet causes the removal of sloughs from the surface of the growth. At the end of this time sepsis in the growth will be appreciably reduced. The suprapubic wound is then opened up further, and the radium tubes are buried in the tumour in the region of the periphery, where the cells are undergoing the most rapid development. So soon as the skin wound has healed, an apparatus for permanently draining the bladder above the pubes should be applied. This consists of a curved metal tube which passes through a metal shield and fits on to a rubber tube which terminates in a rubber bag fixed to the inner side of the thigh by straps. Thus the patient is able to walk about in a moderately comfortable condition.

When Radium Irradiation is Justifiable.—In relation to malignant growths of the bladder this is a question of considerable importance. In expert hands partial cystectomy has given excellent results, and as yet no data have been brought forward to show that any other method of treatment can compete successfully with operative measures. But to ensure the patient a bladder capacity which will give him an undisturbed night's rest, there is a limit to the amount of bladder wall which can be removed. Life is intolerable to the man who is compelled to micturate every half-hour ; and if, in order to cut free of the growth, it is necessary to remove as much as two-thirds of the bladder, then, in the opinion of the writer, excision is not the best treatment. In radium we have a remedy which can be adopted in these advanced cases with a certain measure of success.

The following changes occur on exposure of the malignant growth to the rays : (1) Rapid degeneration of the malignant cells in the immediate vicinity of the tube of radium ; (2) Apparent vacuolation and enlargement of nuclei of those cells beyond the degeneration zone ; (3) Loss of the reproductive function of the cancer-cell ; (4) Proliferation of the connective-tissue cells, which change shows a similarity to the attempt of nature to arrest the development of cancer through new formation of fibrous tissue ; (5) Thrombosis of the blood-vessels, which leads to the arrest of hæmorrhage and shrinkage of the malignant mass.

Such alterations in the character of the tumour cause both an improvement in the local condition and a beneficial effect upon the general health, with prolongation of life. But should an excessive quantity of radium be used, or too prolonged an exposure given, not only will necrosis of the whole tumour result, but also the normal tissues will slough.

MALIGNANT GROWTHS OF THE PROSTATE.

The methods of applying radium to such growths are : (1) *Internal application*—(*a*) per rectum, (*b*) per urethram ; (2) *Burying of radium in growth.*

1. **Internal Application.**—(*a*) The danger of placing radium in apposition to the rectal mucous membrane has already been considered. (*b*) A similar disadvantage is encountered when radium is inserted into the prostatic urethra. The latter becomes inflamed, and frequency of micturition is marked.

2. **Burying of Radium in the Growth.**—The patient, under general anæsthesia, is placed in the lithotomy position. A sound is passed per urethram into the bladder, and an incision made along the median perineal raphé. The tissues between the anterior wall of the anal canal and membranous urethra are then separated. By inserting the finger into the space between the anal canal and membranous urethra the lower pole of the prostate is felt. With the finger as guide, the radium tube is passed into the substance of the gland between the urethra in front and the rectum behind. To obviate the necessity of using a knife, the tube should have one end pointed. Care must be taken that the radium is not pushed into the urethra ; the presence of the metal sound should be of assistance in avoiding this error.

So long as the disease has not spread beyond the capsule of the prostate, removal of the growth by operation is the correct procedure ; but when it has infiltrated the surrounding tissues, e.g., the base of the bladder and the vesiculæ seminales, the use of radium is indicated. The latter treatment will reduce hæmorrhage, because of the sensitiveness of the endothelium to irradiation, which causes thrombosis and thus interferes with the vascular supply of the growth. This is followed by a shrinkage of the tumour and reduction in the frequency of micturition.

Malignant Disease of the Penis.—A growth of the penis can be so readily removed by operation, and with such excellent results, that treatment by radium at the present development of our knowledge is contra-indicated.

New Growths of the Testicle.—Inoperable cases only should be subjected to irradiation ; and such treatment depends upon the extent and anatomical position of the malignant growth. It is only when the secondary deposits are confined to the iliac fossæ that radium is likely to bring relief to the patient. When the disease has spread to the glands along the inferior vena cava and beneath the liver, causing gastric disturbance, no known remedy is of any avail.

The Burying of Radium in Secondary Masses in the Iliac Fossa.—Remarkably good immediate results may be observed from this procedure. The sensitiveness of malignant cells of a testicular growth is so great that a comparatively small dose of radium causes rapid shrinkage of the tumour. The burying of radium in a growth in the iliac fossa is a simple matter, and involves no shock to the patient. Under local anæsthesia an incision is made parallel with Poupart's ligament, and the growth is exposed beneath the skin and subcutaneous tissue. The radium tubes, with pointed ends, are pushed into the substance of the growth and left there from eight to ten hours, after which period they are removed and the skin wound is closed.

CONCLUSIONS.

Little has been said about the dosage of radium, the aim being rather to discuss when and how it should be used in the treatment of malignant disease of the bladder and male genital organs. Reference to a previous article in the *British Journal of Surgery*[4] will give those who are interested in this subject the lines upon which dosage may be determined.

With the experience gained in recent years of the effect of radium upon malignant disease, there is one outstanding fact—radium is local in its action. The removal of a growth by radium does not ensure an immunity from recurrence in other parts of the body. The experiments on mice, which showed that the cancer cell when irradiated with a sub-lethal dose had the power to confer immunity against the same strain of tumour, have as yet failed when put to the test in the case of human malignant disease.

It is the type of growth which rarely gives rise to metastases that is most successfully treated by the rays of radium. Therefore in cases of malignant disease of the bladder and prostate a good result may be expected, provided always that the remedy be applied with meticulous care, and with an exact knowledge of the effect of irradiation upon the normal tissues of the body.

The author's thanks are due to Mr. Hayward Pinch, the Medical Superintendent of the Radium Institute, London, for the loan of emanation tubes for the treatment of his cases at St. Peter's Hospital for Urinary Diseases.

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ACUTE ENCYSTED HYDROCELE OF THE SPERMATIC CORD.

By RAYMOND JOHNSON, London.

Several years ago, when I was seeing out-patients at the Victoria Hospital for Children, one of the employés at an exhibition being held in the neighbouring grounds of the Royal Hospital applied for advice in the following circumstances. Whilst at his work he was seized with sudden acute pain in the groin, and noticed a lump in the same position. There was nausea, but I do not think the patient had actually vomited. The history was negative, and the man was emphatic in his statement that the lump had only just appeared. On examination, a tense oval swelling was found, apparently projecting from the external abdominal ring. The case was regarded as one of strangulated inguinal hernia, and the man was at once sent on to a general hospital, where the same diagnosis was made and an immediate operation performed. I afterwards learned that the supposed strangulated hernia proved to be an encysted hydrocele of the spermatic cord.

Although perfectly familiar with the fact that an encysted hydrocele of the cord may, especially in a child, be confused with an inguinal hernia, I did not at that time know that such a hydrocele might appear so suddenly as to resemble a strangulated hernia; nor did enquiries help me until I found that the condition had been recorded by Curling (*Diseases of the Testis*, 1856, p. 160). The case is described as follows:—

> "A youth, age 15, was admitted into hospital on account of a supposed strangulated hernia. When three years of age he had been subject to rupture on the right side, and had worn a truss for two years, when it was discontinued, as the hernia seemed cured. On the morning of his admission he was seized whilst at work with pain in the right groin, and on feeling the part discovered a small swelling. As the pain was increasing, he returned home, and shortly afterwards vomited. A surgeon who was sent for applied the taxis, and failing to reduce what he supposed from the history and examination to be a hernia, sent the lad to the hospital, when he was again examined, and placed in a warm bath, after which I was summoned to perform an operation.
>
> "I found the lad with an anxious countenance, and affected with nausea. Just below the abdominal ring there was an extremely tense and tender oval swelling the size of a pullet's egg. It had a contracted neck extending into the inguinal canal, received no impulse on coughing, and the testicle was below and distinct from it. On examination by transmitted light the swelling was found to be quite transparent. I at once came to the conclusion that the case was an acute hydrocele of the spermatic cord, and by the application of leeches and ice to the tumour, and the administration of calomel and opium, all the symptoms were relieved. He was discharged in a few days, at which time the fluid had nearly disappeared. Above the swelling there was a slight hernial descent, for which a truss was ordered."

I regret that it has not been possible to find the full records of a second case which came under my care at the Victoria Hospital, shortly after my attention had been drawn to the subject. A child, about 5 years of age, was sent by a medical man as a case of strangulated hernia. The symptoms, which were only of a few hours' duration, consisted of sudden pain in the groin, vomiting, and the presence of a small tense swelling below the external abdominal ring. The diagnosis of acute encysted hydrocele was confirmed at operation.

No similar case presented itself until about a year ago, when I saw a medical friend in the following circumstances. About seven hours previously, whilst trying to start a

rather obstinate motor-car, he felt a sudden pain in the right groin, and a little later discovered a tense very tender lump in the same position. There was considerable nausea, but no actual vomiting. He suspected a strangulated hernia, and on applying at a hospital the same opinion was expressed and operation advised. When I saw the patient there was a tense oval swelling, of about the size and shape of the testicle, in the upper part of the right side of the scrotum. Both the testicles were normal. Hernia was excluded by the facts that the swelling was translucent and that the spermatic cord could be grasped with the finger and thumb between the swelling and the external abdominal ring. The diagnosis of acute encysted hydrocele was made, and the patient assured that with rest the pain and nausea would almost certainly subside, although the swelling might remain. This proved to be the case, and about three weeks later the cyst was tapped and an ounce of clear fluid withdrawn. It did not recur.

These three cases are evidently all examples of the acute form of encysted hydrocele of the spermatic cord so clearly described by Curling. The evidence in the last case is conclusive that the swelling was not appreciable at the moment of the onset of pain, but appeared a very short time afterwards.

The mode of onset, the character of the swelling, and the presence of nausea or actual vomiting, combine to make the resemblance to strangulated hernia very striking.

I am unable to offer an explanation of the condition, and can only suggest that a sudden pressure on the part produced by a forcible muscular effort is sufficient to cause an effusion of fluid into the already present unobliterated portion of the funicular process. The possibility that fluid might have been driven down through a minute opening communicating with a higher part of a bilocular cavity was negatived by the condition found in the second case. It had occurred to me that possibly a small hæmorrhage started the effusion, as is probably the case in many instances of acute bursitis ; but the fluid withdrawn in the second and third cases showed no sign of blood-staining.

It is hoped that the condition is of sufficient rarity and practical interest to justify this short communication.

VISITS TO SURGICAL CLINICS AT HOME AND ABROAD.

THE CLINIC OF SIR ROBERT JONES AT LIVERPOOL.

For some years past Robert Jones's clinic has extended from Aberdeen to London and from Belfast to Dublin. Before the War his chief centres of activity were Liverpool and London, and, now that the War is over, he is again chiefly engaged in these two cities. But as the work which has made him both loved and famous, and the tradition which he inherited from Owen Thomas, are products of the northern city, the present article is confined to a description of the work there.

Fig. 20.—The old chair used by Hugh Owen Thomas.

Although his principal hospital appointment has been that of Surgeon to the Royal Southern Hospital, on the staff of which Jones has been assistant surgeon and surgeon since he was a young man of 21 years, he has also been attached to the Children's Hospital, and during later years the importance of this work has so claimed his attention that he has had to give up other hospital positions and devote himself to the crippled children, and to the founding of new hospitals in the country, more suitable than city institutions for their treatment.

The present writer was privileged to see Sir Robert doing his private as well as his hospital work, and it will be of interest, probably, to describe both, particularly because the former is so closely linked with the history of British orthopædic surgery as taught by Hugh Owen Thomas.

No. 11, Nelson Street, Liverpool, close to the Docks, was Thomas's home, and until a few years ago Jones himself resided there. To-day it is entirely devoted to the purposes of a private clinic, that is to say, offices for consultation, *x*-ray examination, and records. Critchley, the instrument-maker, has his workshops in an adjoining building, and by personal attendance secures accurate and speedy execution of prescriptions for all necessary appliances. The father of the present Mr. Critchley was a metal and leather worker, who was trained by Thomas to make the appliances invented by the latter.

In one of the ground-floor rooms there still stands the special chair with a ring attached to it which Thomas used for the reduction of old dislocations of the shoulder-joint (*Fig.* 20).

As it is only possible for Sir Robert to give two or three days in each week for private work, a great number of patients have to be seen on each occasion, and this necessitates a careful system of secretarial work for the making of appointments and preliminary taking of histories, together with the subsequent keeping of records and indices.

Six small rooms on the ground floor each accommodate one patient, and other rooms, formerly living-rooms, have now been converted into consulting-rooms, so that as many as thirteen patients can be prepared for examination at the same time.

Sir Robert Jones's office, from which all the work is directed, consists of a long studio-room, the walls of which are covered by photographs of eminent surgeons, notable medical caricatures, and anatomical models or casts. Here Sir Robert deals with letters sent with patients, and dictates answers to his stenographer with somewhat bewildering brevity and rapidity. After a short interval the nurse says that a patient is ready in No. 1, and Sir Robert goes with her to see him. On a clip outside the door is a card bearing the chief details of the case to be seen, and with these facts in his mind he goes in to see him and makes his examination. Most of the original consulting-rooms are very small, and arranged with severe simplicity—a couch and a chair being all the furniture, whilst on the wall is a cautery iron over the flame of a Bunsen burner. The preliminary note-taking by a trained assistant makes much conversation unnecessary, but Sir Robert, by his genial remarks made whilst the examination is proceeding, imparts an air of friendly intimacy to the interview which makes the patient and his friends feel that this is the most important case of the day. Details of immediate and after-treatment are given to the nurse; and if sometimes the consultation is over before the patient realizes that it has begun, yet all essentials are secured in the briefest possible time. Sir Robert then returns to his office, and dictates a letter to the medical man from whom the case came, and a note about the result of his examination for his own records (*Fig.* 21). He then goes to another patient.

FIG. 21.—In the office.

The following are typical of the thirty-five patients seen whilst the writer was present:

A footballer from a neighbouring Lancashire town with an injury to the knee, having adhesions in the front of the joint.—Forcible flexion is carried out, and is to be repeated. Certain exercises are prescribed.

A gentleman with a painful back after a hunting accident.—A painful spot is found

over the origin of the right erector spinæ. Manipulation under an anæsthetic, followed by a special belt with a pressure pad over the painful spot.

A child with a weak foot from paresis of the external popliteal nerve.—Special massage and electrical treatment, with a boot raised on its outer edge.

A chauffeuse who had sprained her right wrist, with consequent limitation of rotation and flexion of the wrist.—Adhesions to be broken down under an anæsthetic.

A boy with weak mobile flat-feet.—Boots with raised crooked heel and outside irons; exercises and education; special bandages at night.

Child with spastic paraplegia, the toes being pointed and the legs adducted.—Tenotomy of Achilles tendon and adductors, to be followed by plaster and physical exercises.

A lady with the hip-joint ankylosed at right angles, after a septic infection incurred in 1915.—To have a subtrochanteric osteotomy.

Gentleman with both hips partially ankylosed; no real shortening, but 1½ in. of apparent shortening of the left leg.—Final advice as to treatment deferred until the result of *x*-ray examination was known.

A lady with painful heels, tender bursæ behind both tendines Achillis.—Bursæ to be dissected out.

In some contrast to the concentrated arrangements for consultations, the operative work for private patients is scattered among a number of nursing homes. Those which we saw were typical of the British nursing homes, i.e., they were ordinary dwelling-houses, more or less suitable or adapted for hospital purposes.

In the operative as in the consulting work, all the preliminaries and the after-treatment are arranged and carried out by assistants. The principal assistant who superintends the work in Sir Robert Jones's absence gives the anæsthetics for the operations, and the operative assistant is a nursing sister who has been in this service for many years and accompanies the chief to all his operations in or near Liverpool, in private or in hospitals. She practically organizes the operative programme in all its details of preparation and execution, and her perfect efficiency is one of the secrets of its rapid and smooth working.

Sir Robert follows the usual aseptic technique in regard to dress—he wears cap, mask, overalls, rubber boots, and boiled gloves, while visitors are clothed in cap, mask, gown, and canvas foot and leg covers. The following are brief notes of the four operations which Sir Robert did during the visit of the writer:—

1. Removal of Internal Semilunar Cartilege. *Time of operation*: 9.50 to 10.10.—An adult male, who had had done elsewhere three previous operations for internal derangement. A tourniquet was applied to the upper thigh, and the knee bent over the end of the table, the operator sitting. Incision oblique from above downwards and inwards 1½ in. long. There was much venous oozing, which hindered a good view of the joint. The front portion of the cartilege was frayed, and was removed. No ligatures were applied, but the synovial membrane and capsule were carefully closed by hæmostatic sutures of catgut. The tourniquet was not removed until a firm bandage had been applied. The leg was put up on a short straight back-splint for seven days.

2. Talipes Equinovarus due to Infantile Hemiplegia. *Time of operation*: 10.15 to 10.45.—Tenotomy and tendon transplantation. Tourniquet. Tendo Achillis divided by two lateral incisions 1 in. apart and one longitudinal incision joining the lateral; foot forced up into calcaneal position. The tendon of the tibialis anticus was transferred from the inner to the outer side of the foot by means of three incisions, the first exposing and dividing the insertion of the tendon, the second above the ankle serving to draw the tendon out, and the third over the base of the 5th metatarsal exposing the insertion of the peroneus brevis, to which the tibialis anticus was sewn. The foot was put up on a metal splint.

3. Deformity of Right Hand, Pronation and Flexion of Wrist, and Pointing of Right Foot, due to Infantile Hemiplegia. *Time of operation*: 10.50 to 11.10.—No tourniquet was used for the arm because of the danger of nerve injury. An incision 3 in. long over the postero-external aspect of the forearm, just behind the radial extensor

tendons. The latter turned forward, exposing the tendon of the pronator teres. This was divided and brought through a split in the radial extensor tendons, and there sewn with catgut. The tendo Achillis was lengthened as in the last case. In neither the hand nor the foot was the deformity over-corrected, because in these spastic cases there is always a danger of over-action by the opposite muscles.

4. Unilateral Congenital Dislocation of the Hip-joint in a Girl of 3 years and 9 months (*Fig.* 22). *Time of operation*: 11.20 to 11.45.—A small upright with a pelvic rest was clamped to the end of the table. The thigh was manipulated without any preliminary kneading of the adductors. Very quickly the head of the bone could be seen to jerk into its socket. The thigh was then brought down into abduction and

Fig. 22.—Reducing congenital dislocation of hip.

external rotation, and fixed by a plaster bandage. It is to be kept in plaster six months, being brought down to normal position in three stages. Sir Robert said that whilst at one time he had more than 50 per cent of relapses, this now was quite exceptional. He attributes the improvement to a shorter period of plaster fixation, and to greater attention to securing an anterior position for the head of the bone, with extreme external rotation, at the first sitting.

THE CHILDREN'S HOSPITAL, HESWALL.

Under the influence of Sir Robert Jones, those responsible for the maintenance of the Children's Hospital in Liverpool have very wisely decided to found a large modern hospital right out in the country, where tuberculous and crippled children can get the best possible conditions of sunshine and fresh air. This hospital is at Heswall, on the estuary of the Dee, and the site is ideal for this purpose.

All the patients are in open-air wards day and night, and so rapidly do they derive

benefit from this that their greatest punishment is to be kept indoors for any length of time.

Case 1.—Poliomyelitis. Paralysis of Quadriceps. *Time of operation*: 3.25 to 3.40.—A tourniquet was applied. The biceps tendon was exposed by an external incision, and cut as low as possible. The patella was approached by a median incision, and the aponeurosis over it, and the superficial cartilage, tunnelled through from the mid-line to the outer edge. The end of the biceps tendon was drawn up into this tunnel and fixed there by catgut stitches.

Case 2.—Poliomyelitis. Talipes Valgus. *Time of operation*: 3.45 to 4.0.—The foot having been thoroughly wrenched, the peroneus longus tendon was exposed by two short incisions, the first over the cuboid bone and the second 3 in. above the ankle. The tendon was divided at the former, and then drawn up into the latter incision. On the inner side of the foot the insertion of the tibialis anticus was exposed, the long peroneal tendon brought through a split in it, and sewn there, after fully correcting the deformity.

Case 3. Genu Valgum. *Time of operation*: 4.15 to 4.25.—Through a small incision above the outer side of the knee, an Adams saw provided with a knob at the end was inserted after guiding with a director. The femur was cut half through and then broken. Incision closed by two stitches. Leg put up on a Thomas splint on which it was to be left for five weeks.

Case 4. Poliomyelitis. Extreme Talipes Equinus with Pes Cavus. *Time of operation*: 4.40 to 4.50.—The plantar fascia and the five extensor tendons were divided by subcutaneous tenotomies. The front of the foot was moulded by wrenching. The tendo Achillis was lengthened by a sliding tenotomy. Foot placed on a metal splint.

THE SURGICAL AND ORTHOPÆDIC HOME, BASCHURCH.

More than fifty miles from Liverpool, in the heart of Shropshire, is one of the most remarkable hospitals we have ever seen. It is so peculiarly the outcome of Sir Robert Jones's enthusiasm and inspiration that we feel tempted to describe its genesis and history, but this might trespass too much on the space at our disposal.

Fig. 23.—Two convalescent cases at Baschurch.

In the year 1900 Miss Hunt, a lady living at Baschurch, who had been reclaimed from invalidism to activity by Sir Robert, began to collect crippled children, whom she conveyed once a week to Liverpool, that they might receive the benefit of his healing art. Very soon a country house was filled with these patients, and from time to time a shed or two were added—a simple operating-room (costing £120), a lean-to as a plaster-room, a gipsy caravan as a portable 'isolation ward', and other non-descript buildings, until at present there is a surgical unit of 200 beds, in which, as it has been said, "the curative value obtained per pound spent was greater than in any other institution in the world".

It certainly is a remarkable demonstration of the superiority of mind over matter, that in this curious jumble of shanties there is actually to be seen some of the finest possible surgical work in all stages of completion.

On the Sunday when we made our inspection, there was an attendance of about twenty medical men and women attracted by the special visit of Sir Robert Jones, who during the War has only been able to go there at rare intervals.

FIG. 24.—A group of patients.

In the first place, special cases sent for consultation were seen. These numbered seventeen, and presented all grades of difficulty, from a case of multiple spontaneous fractures associated with a doubtful malignant metastasis, and a case of rupture of the posterior crucial ligaments in both knee-joints, to those of the more ordinary gunshot injuries of the limbs, tuberculous spines, and deformed feet.

Not only was appropriate treatment suggested for each case, but where apparatus, e.g., splints or plaster, was required, this was to be made at the hospital by lady assistants and patients.

In the operating-room, primitive but efficient, the same care for aseptic precautions was observed as in the most ornate modern hospital.

FIG. 25.—Splint-room—girls at work.

Case 1. TORN INTERNAL SEMILUNAR CARTILAGE. *Time of operation*: 2.10 to 2.25.—Tourniquet. Knee flexed over end of table; oblique incision; removal of frayed cartilage; suture of synovial membrane and capsule in separate layers. Skin sutured with silkworm gut; dressing applied with firm bandage; leg straightened; tourniquet removed. The operation was bloodless, and a perfectly clear field for observation provided.

Case 2. POTT'S DISEASE OF THE SPINE. *Time of operation*: 2.35 to 3.0.—Modified Hibbs's operation; an adult female with caries in the mid-dorsal region. A plaster case had been fitted to the trunk, made in an anterior and posterior portion; to the anterior case a metal frame supporting the forehead had been fixed, so that when the patient was

laid on her face and the back exposed, the head was held in position over the end of the table, conveniently for anæsthesia. A scab over the prominent vertebra was excised; an 8-in. incision exposed six dorsal spines, which were freed from muscle and ligaments;

FIG. 26.—Babies' sun-bath.

each spine was partly divided into three longitudinal pieces; the lateral pieces were turned alternately forward and backward so as to imbricate upon one another. The muscles

FIG. 27.—Open-air life.

were sewn over the spinous processes, the wound closed, and the posterior plaster case replaced.

Sir Robert Jones stated that this operation was only suitable for adults, and that in

such it gave a firm mass of bone, which served to immobilize the affected spine. He only does Albee's operation in exceptional cases, especially for very localized disease of the lumbar vertebræ.

Case 3. Infantile Hemiplegia. *Time of operation*: 3.15 to 3.30.—Transplantation of the biceps tendon to the patella, to equalize the power of the extensors and flexors of the knee.

Case 4. Ankylosis of Hip from Tubercle in a young Adult. *Time of operation*: 3.40 to 3.50.—Tenotomies of the adductors and tensor faseiæ femoris; transtrochanterie osteotomy by Adams's saw passed across the trochanters parallel to Poupart's ligament. The bone was hard and difficult to divide; it was cut through partly, and then broken. Put up in an abduction frame.

Case 5. Congenital Talipes Equinovarus. *Time of operation*: 4.0 to 4.10.—Wrenching, followed by plaster. Each element of the deformity was corrected as far as possible, first manually and then by Thomas's wrench, until the foot was flabby—almost flail. It was then put up in plaster in a fully-corrected position. In advanced cases where excision of bone or osteotomy has to be done, Jones condemns the practice of such bone operations until the maximum correction by wrenching has been carried out.

One of the special features of the work at Basehurch is that of the after-care of the cases at various village centres situated all over Shropshire. This is undertaken by trained lady assistants, who do their long rounds on motor-cycles, visit the patients, and fit splints and remove or re-apply plaster dressings.

The above description, which intentionally avoids either critical or laudatory comments, represents three days' work in Sir Robert Jones's clinic, and it filled the writer with great enthusiasm, which it is hoped he may have been able to convey to the reader in some measure by this simple word-picture.

THE TREATMENT OF INOPERABLE CANCER WITH SELENIUM.[1]

By E. WATSON-WILLIAMS, Bristol.[18]

The attempt to eradicate malignant disease by injections into the blood-stream is of recent origin. The pathogenesis of cancer is as yet unknown; but it has long been our hope to discover some preparation that would cause the destruction of the proliferating cells, whether this proliferation be the entire morbid process or merely the manifest termination of other hypothetical local changes. It having been observed, however, that cancerous tissue possesses the property of concentrating in itself the mercury given for the treatment of syphilis, experiments were conducted to discover if other elements might not likewise be selected with this object in view: for it appeared possible that, if it were so, a protoplasmic poison might be given in doses which, though small enough not to injure the patient, might yet become sufficiently concentrated in the cancerous cells to effect their destruction. It was found that a large number of elements, chiefly metals and metalloids, show this affinity in greater or less degree; of these, copper is the best known in this country.

In 1911, Wassermann, working with carcinomatous mice, found that injection of a solution of selenium-eosin produced remarkable changes in the tumour.[17] Frequently, severe hæmorrhage occurred into it; with or without this phenomenon—a common feature in radium treatment in mice—many of the tumours were absorbed more or less completely: it appeared that a cure for cancer was available. The discovery naturally aroused great interest; the intensely poisonous nature of the medicament, however, rendered its direct application to human patients too hazardous. The difficulty was surmounted by the preparation[9,13] of a colloidal suspension of selenium. Briefly, this is a suspension of ultramicroscopic particles, of a size comparable with those of the largest molecules, in a very dilute solution. Such a fluid does not give the chemical reactions characteristic of a solution, since these depend on the presence of ions of the substance dissolved, which do not, for practical purposes, exist in the suspension. A commercial preparation was shortly available, and its toxicity having been shown by animal experiments[3] to be negligible, the way was open for therapeutic application of the remedy.

Selenium is a somewhat rare non-metallic element of atomic weight 79·1, resembling sulphur in general chemical properties. It was discovered in 1817 by Berzelius in the refuse of a sulphuric acid works. It is widely distributed in nature as an impurity of sulphides of various metals and otherwise. Of the element, five allotropic forms are described, of which two are red and three black. Only one is of importance in the present description, the brick-red selenium-β. It was first used medicinally for cancer by Stapf in 1833, and has subsequently appeared in various powders and pastes employed by the profession, and also by commercial enterprises, for the relief of malignant ulcers. The intensely poisonous nature of all its soluble compounds was inimical to its success, and interest in this element has been practically confined to the curious photo-electric properties of the 'black metallic' allotrope.

Preparations of Selenium.—Following the experiments of Wassermann, Comar et Cie, of Paris, produced a colloidal suspension of selenium. This is a coral-red fluid, 'electroselenium', and is stated to be electrically-prepared colloidal selenium-β. The strength is 1–5000 of the element; the particles are said to be of the diameter of 5 to 20 $\mu\mu$; this probably refers to the approximate size of the smallest particles. It is isotonized by the addition of sodium chloride, and sterilized. This preparation will be referred to as Se C. No attempt appears to have been made to 'protect' the suspension colloid by

the addition of emulsion colloid. Perhaps the early depression phase of the general reaction reported by those who used it is partly attributable to this ; one would certainly expect some shock after intravenous injection of unprotected suspension colloid.

A fluid chemically prepared by Messrs. Crookes (Se O) was available in England, and was used in the earlier cases tabulated below. This was of a strength of 1–1000, and isotonized with sodium chloride. A method of preparation is given in the *Extra Pharmacopœia*.[11] It was found, however, not to be satisfactory : in particular, the precipitation which one would have expected, frequently occurred. Messrs. Crookes therefore evolved a more suitable injection, 'collosol selenium' (Se N), with which the bulk of these observations have been made. This is a dichroic coral-red fluid consisting of a sterile 1–2000 chemically-prepared colloidal suspension of selenium-β, protected by the presence of suitable emulsion colloid (peptone), and isotonized with glucose. The 'intravenous' preparation contains particles up to a slarge as 500 $\mu\mu$; the 'intramuscular' contains even larger particles, up to 800 $\mu\mu$ approximately : there appears to be no other difference. The liquids have proved very stable. The series quoted below is too short for accurate comparison, and only a few cases had more than one preparation ; but that last described appeared to be the most active, and has never given rise to those symptoms of shock which were not uncommon after the intravenous injection of some of the other preparations.

Martindale's preparation (Se S) was Crookes' 1–1000 diluted to 1–5000 and isotonized at the time of injection.

A few experiments have been conducted with an allotropic modification, selenium-α ; but this appears to be inactive.[19]

Technique.—The suspension may be given by intravenous or intramuscular injection. Injected subcutaneously or into intermuscular areolar tissue, it causes pain and is not well absorbed. Intramuscular injection is not very painful, and the clinical results appear the same as by the intravenous route. Injection into the gluteus, or in a bed-ridden patient into the deltoid, appears to be best : a limit of about 5 c.c. has necessarily to be placed on the dose by this route. It is, however, useful to avoid a marked reaction in feeble patients, or where, in the debilitated, the veins are difficult to inject.

The intravenous route is to be preferred. Either 'intramuscular' or 'intravenous' suspension may be given. The general reaction is never alarming, and only very occasionally noteworthy. The focal reaction is more abrupt in onset and somewhat more intense. As much as 20 c.c. daily has been given by this route with no ill effects. The quantity of emulsion colloid present is so small that no serum change appears to occur ; the suspension colloid would presumably not give rise to one in any case. Many of the injections have been given in the out-patient department, and the patients allowed to go home half an hour later. No special precautions appear to be necessary ; if, however, a leak into the subcutaneous tissues occurs, a fomentation helps to minimize the local irritation. The same vein may be used day after day.

Although the cases tabulated show a wide variation in periodicity and size of dose, an attempt has been made to adhere to the following scheme :—

A dose of 5 c.c. on the 1st and 3rd day, followed by 10 c.c. on the 5th, 8th, 10th, and 12th days ; then a month's rest, to be followed by 10 c.c. twice a week, until a total of 100 c.c. have been administered in all.

In the presence of a large growth, smaller doses are given ; for a small one, or after extirpation of the bulk of the tissue, daily doses of 10 c.c. or more may be used. One is, of course, prepared to diminish or stop the administration in the event of much disturbance, or other evidence of intolerance. The dosage recommended above has never given cause for the least anxiety. Injections of 10 c.c. once a week can also be used if more convenient ; the total dose required is about the same. Two cases developed intolerance, as evidenced by myalgic pains and hæmaturia, in the course of prolonged administration : two showed some intolerance almost from the start. The symptoms disappeared entirely on stopping administration. Later courses have been used in a few cases : the data are not sufficient for a pronouncement on their value.

Effects of Treatment.—The immediate effects following on a single injection fall into four groups. Within a few minutes, with one preparation—'electroselenium'—a mild degree of shock is occasionally noticeable. There is a rigor sometimes, more commonly some collapse, with thready pulse, low temperature, and a feeling of nausea and faintness. This passes off in from ten to forty minutes. It has not been observed after intramuscular injections.

A reaction is usually noticed by the patient first in the growth itself, especially where this is in a sensitive situation such as the tongue or larynx. The part feels hot, heavy, and stiff. A definite focal reaction can be observed shortly after, usually in four to six hours from the injection. Slight tumescence of the growth from increased blood-supply is apparently the cause, probably arising from irritation by the local deposition of selenium. Some œdema also occurs, and is less transitory. The effects are not very marked objectively; in discharging growths the discharge may be temporarily increased.

Following shortly upon this the general reaction, properly so-called, takes place. A rise of temperature to 100° or 101°, rarely more, with some headache and malaise, is fairly common. It is held to be due to absorption into the circulation of material destroyed by the drug. It occurs from six to ten hours after injection, and lasts about the same period. For equal doses the subjects of large tumours suffer a more considerable reaction;[2] this observation supports the suggested theory of causation. This reaction is less marked after later doses than after the earlier, and is not observed at all in many cases. The focal and general reactions have been taken as an indication of the clinical activity of the preparation given.

Twenty-four hours after administration other than intravenous, a local reaction is seen at the site of injection. Some redness, swelling, and stiffness are the only symptoms noted. They subside without causing trouble: no case of abscess formation or similar complication has been recorded.

Of the fate of the drug after injection, little is known. Experimental evidence regarding its fixation in the malignant tissue, its effect on excretions, etc., and its own excretion, is referred to below.

The effects following a course of injections are usually well marked. They are gradual in their appearance, and the improvement continues for some time after the injections have ceased.[18] (1) The first effect is noticed by the patient, and is a local one: Diminution or disappearance of pain. In a favourable case there follow: (2) Diminution in tenderness; (3) Cleansing of ulcerated surfaces, decrease of discharge, granulation; (4) Diminution in size and hardness of the tumour and secondary deposits; (5) Increased mobility of the part. In the general condition one may note: (6) Improvement in anæmia and cachexia; (7) Improved sleep and memory; (8) Increase in weight and strength; (9) Marked psychic improvement: this is due partly, no doubt, to the feeling that something is being done, but is also largely attributable to relief from pain, sleeplessness, and the intolerable discomfort of fœtid discharges.

All these results do not follow in every case, nor is the improvement always permanent. Some, however, of the patients treated were in such a condition as to preclude this hope; but nearly all experienced considerable benefit. Broadly speaking, those patients with growths in vascular areas such as the alimentary tract, bladder, or uterus respond best to treatment; those with mammary, laryngeal, tonsillar, recurrent, or very rapidly growing tumours derive less benefit, as also do very aged or debilitated patients. In a few cases the formation of a firm cicatrix has, by its interference with function, somewhat marred the result from a clinical point of view. But when destruction of tissue has occurred, a cicatrix is the best that can be expected, and in any event is almost certainly preferable to a malignant ulcer.

Indications for Treatment.—The treatment appears to be suitable for two classes of patient. In inoperable cases, the results obtained compare favourably with any known method of attacking the growth by the blood-stream, and are approximately equal to those of radiotherapy. The moderate focal reaction is in no way comparable to the local reaction from radium: the preparation appears to be considerably more active than

copper given as cuprase or copper alanin. All malignant tissue is affected, however inaccessible. As a purely palliative treatment, the drying of ulcers and abolition of pain is a marked advantage. The injections have the minor advantage of low cost.

As an adjunct to operative measures, including diathermy, the treatment may be applied to a variety of conditions. Where operative removal has not been as free as desirable, the possible outlying cells might be destroyed by injections. In patients having a course of injections, wounds in carcinomatous tissue have been observed to heal. Cases pronounced inoperable may give hope of becoming operable when sepsis and fixation have been diminished by this treatment. Possibly malignant processes might be held in check for a few weeks in patients who cannot arrange to submit to an operation at short notice: time is necessary before deciding as to the value of selenium in such cases.

Contra-indications.—There appear to be no positive contra-indications to this preparation. Caution is, of course, desirable in cases of carcinoma of the larynx, secondary mediastinal deposits, or other conditions in which tumescence of the morbid tissue might cause embarrassment. With 'electroselenium' especially there appears to be a tendency for glands to undergo aseptic colliquefactive degeneration; it is doubtful, however, whether this is entirely to be attributed to the drug, and in any event it is not a troublesome feature.

Results of Treatment.—Before leaving the subject of treatment, it will be convenient to give a few notes of the results already achieved with this preparation. The cases it has been found possible to collect are briefly analyzed in the following table. Nearly all the investigators used 'electroselenium,' and injections were made by a variety of routes—subcutaneous, intramuscular, intravenous, and into or near the tumour.

Table I.—Analysis of Cases.

Investigator	Number of Cases	Injections					Improvement		
		Average dose in c.c.	Average number	Interval in days	Average total dose, c.c.	Largest total dose in one case in c.c.	Considerable	Appreciable	None
Cade and Girard [4] ..	8	5	15	3	75	100	2	3	3
Bougeant and Galliot [3]	12	5	20	2	100	250	12	—	—
Blumenthal [2]	6	—	—	—	—	—	2	4	—
Trinkler [16]	4	5	9	2	45	55	4	—	—
Touche [15]	27	5	5	7	25	130	9	11	7
Hope [10]	2	5	3	7	15	15	2	—	—
Carles and Vieron [5] ..	10	3	20	3	60	100	6	—	4
Conseil [6]	5	5	—	—	—	—	3	—	2
Others	16	—	—	—	—	—	13	1	2
Totals	90						72		18

Lidy reports a number of cases, but details are not available.

Table I shows that about four in five of the cases benefited. Eight are reported as apparently complete cures clinically.

The general effect of the administration of selenium as reported by these investigators is substantially in agreement with that found in the cases reported below. They observed on the whole a more considerable general reaction, but make little mention of any focal reaction, that is, immediate change in the morbid tissue. It seems not entirely probable that the large constant general reaction was due to a more active preparation, as in my

series it was found that the 'collosol selenium' appeared considerably more active than 'electroselenium'. These and other observers have, however, elicited a number of facts which throw light on the mode of action of the element; as it is exceedingly difficult to detect it with certainty in very small amounts, it has not been practicable to repeat their observations.

Mode of Action.—Given in relatively enormous doses to animals,[8] the element was found to remain, after all excretion ceased, in certain tissues. In the first place, it was not found possible to kill rabbits by daily injections for 60 days, although a single injection containing the same dose and concentration of selenious acid produced death in a week. On killing the animals and analyzing the organs, selenium was found in the liver and the blood. Traces were also observed in the bones, lungs, heart, suprarenals, and testes. Congestion of the kidneys was also observed: the other tissues were histologically normal. Observation on human subjects, who had been given relatively very much smaller doses, showed that the element can be recovered in quantity from the cancerous tissue[7,12]. The urine of cancer patients increased in toxicity after injection; that of healthy controls did not.[5] A marked leucocytosis followed the injections; there was also a rise of temperature,[2] again peculiar to cancer patients, and roughly proportional to the size of the tumour for similar doses of the drug. These facts support the view of a flooding of the circulation with the products of autolysis of cancer cells to which the action of the drug has been ascribed. The cancerous tissues affected by the drug showed nucleolysis[12] and minute areas of hæmorrhage. The drug is excreted in the urine;[8] its effect on the solid constituents of the urine is in dispute.[4] Prolonged administration may give rise to a transient albuminuria. Colloidal selenium has no effect on ordinary pathogenic bacteria *in vitro*:[11] this does not preclude the possibility of a germicidal effect *in vivo*. Dead cancerous tissue shows no affinity for the element.[14]

From these observations it is possible to deduce a theory of action of the drug. It would seem that cancer tissue, by reason of some peculiarity in itself, has a special affinity for it. In any appreciable concentration it probably acts as a protoplasmic poison, causing destruction of the cells or their nuclei (or even, if these exist, of the parasites contained in them). It is of course possible that it exercises a merely germicidal action, and that the good clinical results are due to this. It is true that a number of patients did not continue the initial improvement, even on increased doses. In several cases, however, definite arrest of the malignant processes appears to have occurred. Relatively very small doses of the element could be given; and it is possible that if one could give much heavier doses the improvement would be more constant and permanent. Attempts are believed to have been in progress in Berlin during the last five years to produce an organic compound analogous to salvarsan: no reports, however, as to the results obtained are yet available.

SUMMARY.

Whatever theory of the causation of malignant disease proves to be correct, and whatever the mode of action of a particular remedy in any case, the value of the treatment must depend on the results obtained, not in the laboratory, but with patients.

Table II shows the dosage and results in twenty cases.

The remaining cases received a few injections only. Neglecting *Cases* 15 and 18, in which radium was used in conjunction, there remain 18 cases. Apparent arrest of the malignant process was observed in 6 of these; diminution could be inferred from observation in 5 more; the condition of the remainder was inconclusive. Two cases showed apparent complete relief of their symptoms; 5 were relieved of all or nearly all their symptoms, and so remained through the period of observation; 7 more experienced considerable relief for a longer or shorter period. That is, apparent arrest, and relief of symptoms, followed treatment in one case out of three; and in the whole series the majority experienced a considerable benefit. The series is of course a very small one from which to draw conclusions, and the period of observation is too short for the formation of pronounced views. The hopes that the almost universal early improvement inspired

have unhappily not been fulfilled, and it is to be feared that the proportion of apparently successful results will be reduced as the period of observation lengthens.

Nevertheless, from these instances one may justly conclude that the injection of colloidal selenium has established a definite claim for consideration in certain cases as a therapeutic measure :—

1. In a class of patients whose outlook has till recently been almost hopeless, a very considerable degree of benefit may be expected.
2. Pain, sleeplessness, ulceration, and discharge are markedly diminished.
3. In favourable cases a fair degree of comfort is attained (several returned to work).
4. In a few cases the degree of relief comes within measurable distance of a 'cure'.

Table II.—Dosage and Results in Twenty Cases.

No.	Site of Tumour	Injections							Period of Observation in Months	Result	
		Route	Preparation	Average dose in c.c.	Number of doses	Average interval in days	Total dose in c.c.	Total dose in mgrm.		Arrest of malignant process	General and local relief
1	Pylorus	M	O	3½	15	3	50	50	4	—	T R
2	Colon	M	N	5	2	3½	10	—	—	—	—
		V	N	5	4	3½	20	15	4	?	I
3	Breast	M	N	5	14	3½	70	35	3	—	T I
4	Breast	M	N	5	10	3½	50	25	4	?	R
5	Stomach	M	O	3½	2	2	7	—	—	—	—
		V	N	5	15	5	75	44	7	A	Cd.
6	Cheek	M	O	3	7	2	20	—	—	—	—
		M	N	5	9	3½	45	42	4	T	T R
7	Uterus	V	N	8	6	2	50	25	1½	A	R
8	Uterus	V	C	7	7	3½	50	20	2	None	?
9	Uterus	V	N	5	4	3½	20	—	—	—	—
		M	N	10	3	3½	30	25	2	A	R
10	Bladder	V	N	7	12	3½	82	41	4	A	R
11	Parotid	V	N	12	8	2	95	47	2	—	Neg.
12	Tongue	V	N	9	11	2	105	52	8	T	T R
13	Tonsil	M	N	5	10	1	50	—	—	—	—
		V	N	14	6	3	80	—	—	—	—
	2nd course	V	N	10	4	7	40	85	5	A	R
14	Tonsil	M	N	5	6	2	30	—	—	—	—
		V	N	11	6	3½	63	—	—	T	—
	2nd course	V	C	10	2	7	20	50	6	—	T R
15	Tonsil*	V	N	9	7	1½	65	32	1	—	Neg.
16	Larynx	V	C	8	8	2	60	—	—	T	—
	2nd course	V	N	10	7	2	70	47	5	—	T R
17	Larynx	M	S	4	9	2	35	—	—	—	—
		V	N	10	6	3	57	35	6	T	T R
18	Larynx*	M	S	3½	8	1	30	—	—	—	—
		V	N	8	6	3	50	—	—	—	—
		V	N	10	5	3½	50	55	5	A	I
19	Larynx	V	S	4	7	1	25	—	—	—	—
		V	C	5	1	—	5	—	—	—	—
		V	N	10	18	5	170	91	6	T	T R
20	Œsophagus	M	N	5	8	2	40	—	—	—	—
		V	N	15	6	3½	87	63	7	A	Cd.

M. Intramuscular ; V. Intravenous ; N. 'Collosol' selenium ; O. C. S. Other preparations (see text) : A. Apparent arrest of malignant process ; T. Temporary ; R. Relieved of symptoms ; I, Improved ; Cd. Apparently cured ; Neg. Not appreciable.

* Radium used in conjunction.

Complete reports of a few cases are appended. The remainder, and acknowledgement of my great indebtedness to a number of surgeons, are published in the original thesis.[1]

SELECTED CASES FROM *Table II.*

Case 5.—**Carcinoma of great curvature of stomach.** Female, 37. Nurse.

History.—Vomiting blood. One year's history. Dyspepsia a year ago, with melæna; subsided on resting. Recurred a month ago and became worse. While in bed she felt suddenly sick and faint, and vomited about a pint of blood.

On Examination.—Epigastrium is tender, nothing felt.

Laparotomy: A large nodular carcinomatous mass in posterior wall of greater curvature of the stomach, binding it to the abdominal wall. Possibly an adherent carcinoma of the pancreas. A crateriform ulcer one and a half inches across was felt in the posterior wall of the stomach through the anterior wall. Secondary nodules in the liver.

Since the hæmatemesis pain has been constant and severe. On a fluid diet it is continuous and prevents sleep. There has been marked anæmia and wasting. No further melæna noticed. Vomiting, but not of blood, after most feeds. The laparotomy was undertaken as an emergency, as she had had no sleep for three nights in spite of large doses of morphia, and was becoming exhausted.

The day after the laparotomy 2 c.c. selenium O were given intramuscularly, followed by a dose of 5 c.c. The patient said she felt better. Five c.c. selenium N were given intravenously twice a week for five doses, then once a week for other ten doses. The pain after meals disappeared, and the patient returned to a general diet, avoiding butcher's meat and roots only. Sleep soon became normal, morphia being discontinued after the second dose. Some œdema of one foot appeared, doubtless from swelling of secondaries, but soon subsided. She put on flesh and began to get about. Intolerance, evidenced by myalgia and malaise after injection, appeared, and the injections were stopped. The patient, a nurse, thinks that her convalescence from 'gastro-enterostomy' was rather slow (the operation, of course, had not been performed); but proposes to return to work soon, apparently cured.

Total dose, selenium O 7 c.c., selenium N 75 c.c. = 82 c.c. Observation seven months. Apparent cure.

Case 9.—**Carcinoma of the cervix uteri.** Female, 53. Housewife.

History.—Blood-stained and, later, fœtid vaginal discharge; three months' history.

On Examination.—A mass can be seen and felt in the vagina, replacing the cervix. It is nodular, friable, and in the centre deeply ulcerated. The wall of the bladder, the uterosacral ligaments, and the right broad ligament are extensively involved. There is a constant burning pain in the vagina; gentle examination is painless. A profuse stinking yellow discharge is present. Constipation has recently appeared, with frequent and painful micturition. She has lost a lot of flesh recently. The appetite is poor; sleep fair; complexion pallid, but not cachectic.

Under ether, the uterus was curetted. The pathologist reports 'epithelial carcinomatous masses'. The uterus was packed with formalin. Five days later pain was worse, and in lower abdomen. The fœtid discharge was as before; an extension of the growth on the vaginal fornix was observed.

Four intravenous injections of 5 c.c. selenium N were given, followed by three intramuscular of 10 c.c., two a week. No marked general reaction was observed, except a rise of temperature to 100° after the sixth, with malaise and headache. No focal reaction was noted. There was some tenderness and stiffness at the site of the intramuscular injections. The fœtor and pain diminished rapidly. The discharge completely dried up after the last injection. Constipation was unchanged, but micturition became normal. Weight remained stationary.

Total dose, selenium N 50 c.c. Observation two months. Relieved.

Case 10.—**Carcinoma of bladder.** Female, 56. Housewife.

History.—Inability to retain urine and fæces, pain in urethra, and wasting. Eight months' history.

On Examination.—A large mass is felt per vaginam deep to the anterior wall of the vagina and attached to it. The uterus is small and mobile. The mass is hard, irregular, and surrounds the neck of the urethra; it is tender. Per rectum the same. Cystoscopy: nothing valuable could be seen owing to the presence of blood. Hard glands in both groins, with acute pain and attacks of retention. There is abdominal pain fairly constantly. Recently incontinence of urine (with empty bladder) and of fæces has been troublesome. Loss of weight, appetite, and sleep marked; anæmia and lassitude noticeable. The patient was in a miserable condition, constantly soaked in urine, less constantly soiled with fæces. The urine contained a great deal of blood and pus. Morphia in increasing doses was required nightly.

Three doses of 2½ c.c. selenium N were given intravenously, followed by three of 5 c.c. and six of 10 c.c., two a week. Morphia was discontinued after the second dose. No general reaction, except after the first dose, and no focal reaction, were observed. Incontinence ceased after the fourth dose. Hæmaturia, pain, and tenderness—even on catheterization—disappeared after the sixth. The growth appeared softer, but same size; the glands in the groin were considerably smaller. Two months later the patient was up and about, though still feeble. She required a catheter, but there was no pain or difficulty in using it. She had ceased to lose weight. The

anæmia was less, and her general condition enormously bettered. There had been no further hæmaturia ; the patient had not again required morphia.

Total dose, selenium N 82·5 c.c. Observation four months. Apparently an arrest of malignant process.

Case 16.—**Carcinoma of larynx.** Male, 50. Gardener.

History.—Pain in throat and roof of mouth, intermittent, and worse on swallowing. Six months' history. There has been one hæmorrhage from throat, but no other symptoms at all, except recently loss of sleep, and some hoarseness.

On Examination.—The right aryteno-epiglottidean fold is ulcerated away, being replaced by a nodular mass, which obscures the anterior end of the larynx. The epiglottis and neighbouring structures are swollen. Some glandular enlargement. Weight, appetite, sleep, and memory normal.

Selenium C was given in four doses of 5 c.c. on alternate days, then four of 10 c.c. A general reaction—shivering, malaise, headache, and giddiness—followed soon after each injection ; a focal reaction was noticed about four to six hours after. The pain and sleeplessness disappeared, and patient resumed work. Two months later he returned with very fœtid breath and a cystic gland. Ulceration had recurred, and the laryngeal tumour was larger. The gland was incised, and 3 oz. glairy fluid evacuated. The wound healed by first intention. Fluid subsequently collected, and was withdrawn on several occasions. Selenium N, 10 c.c., was given on alternate days up to 70 c.c. After the fifth dose he "had the first uninterrupted night for five weeks". A vigorous focal but no general reaction followed each injection. He was conscious of a great feeling of relief as the reaction subsided. The difficulty in swallowing persisted, though pain vanished. The malignant process appeared to be steady, but much slower than before the injections.

Total dose of selenium C, 60 c.c., selenium N, 70 c.c. Observation six months. Temporary relief. The patient died suddenly from hæmorrhage a short time ago.

Case 19.—**Carcinoma of larynx.** Male, 69. Labourer.

History.—Hoarseness of six weeks' duration, and pain on swallowing. Sleep poor, nutrition fair.

On Examination.—An extensive cauliflower growth involved the right aryteno-epiglottidean fold, from epiglottis to cricoid. The growth was not ulcerated. Pathological report, 'carcinoma'. A large gland, not tender, was found on right side of thyroid.

Selenium S, 2·5 c.c., was given daily for four days intravenously, followed by 5 c.c. doses for three days. The pain was a little improved, but no other change was noticed. One dose of 5 c.c. selenium N was given, followed by eighteen of 10 c.c., at first every third day, later once a week. One dose of selenium C was given. No general reaction occurred, but a focal reaction was noticed after every dose but the first. The pain completely disappeared with the second dose, the growth shrank enough for the vocal cord to be seen, the voice became almost normal ; the gland became smaller. Sleep improved. The weight increased 6 pounds. About half-way through the course the growth had ceased to be nodular and showed as a cherry-like smooth mass in the fold, half appearing medial and half lateral to it.

Later, the surface ulcerated, and sepsis became very troublesome. Bronchitis and dysphagia followed. Six months from the beginning of treatment, laryngeal œdema necessitated tracheotomy ; the patient died of bronchopneumonia shortly after.

Total dose, selenium S, 25 c.c., selenium C, 5 c.c., selenium N, 170 c.c. Observation six months. Temporarily relieved.

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ON THE OCCURRENCE OF MASSIVE CHOLESTERIN DEPOSITS IN THE BREAST IN CASES OF LONG-STANDING MASTITIS.

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Cholesterin in crystalline form may be deposited in the tissues in many situations and as a result of divers pathological processes. In most cases the crystals make their appearance in consequence of local tissue disintegration, whether from necrosis or from the retention of inflammatory exudates or effused blood. In certain situations, such as the breast, an additional possible factor is the retention of secretory products which results from duct obstruction.

The tabular form of cholesterin is most frequently met with, giving rise to the well-known appearance of clefts in paraffin sections; less often the acicular crystalline form is assumed. When the crystals are deposited in, or come to be surrounded by, living connective tissue, they stimulate the formation of a very special cellular reaction round about, in which foreign-body giant cells and endothelial cells with foamy cytoplasm form the most prominent feature.

In the breast, certain forms of subacute inflammation with retention of the secretions have been found to be associated with the deposition of cholesterin crystals, mainly of the acicular type. These occur within the lumen of the inflamed and dilated ducts, and when once the epithelial lining has been shed, they become surrounded by a complete ring of foreign-body giant cells, from which fine cytoplasmic processes run inwards between the individual crystals. These giant-cell rosettes are highly characteristic structures as seen in paraffin sections, and may be present in quite considerable numbers. In a few instances plate cholesterin has also been demonstrated amongst the inflammatory tissue.

The total amount of cholesterin present in the breast in such circumstances is usually quite small, but, exceptionally, very large quantities may be deposited. The writers have had the opportunity of studying two such cases, the details of which follow:—

Case 1.—(1903.)

Clinical History.—The patient, a woman, age 63, gave the following history. She was married in 1860 at the age of 19, and her first child was born ten months later. Her second and only other child was born nine years after the first. In the interval she had a miscarriage, and she also had an abscess of the left breast, which, however, had quite recovered by the time the second child was born. Both her children were suckled on both breasts. In 1893, ten years before admission to hospital, she received a blow on the left breast. Thereafter, a small, hard lump made its appearance in the breast and slowly increased in size, while latterly the nipple discharged blood and 'matter' from time to time. Towards the end of 1902 there was a rapid increase in the size of the tumour, which became also less mobile and very painful, while the skin over it became inflamed.

On Admission to hospital on January 10, 1903, the breast was very much enlarged and inflamed. Parts of the tumour were hard and nodular, but in the centre near the nipple it was soft and fluctuating. The skin here was stretched and shining, and of a dark-purple colour, and on the day following admission it ruptured, allowing the escape of a large quantity of glistening, blood-stained serous fluid. There still remained within the cavity a soft, jelly-like, semifluctuant material, which gradually disappeared in the course of the day, leaving the cavity lined by what were thought to be sprouting granulations. No enlarged glands could be felt in the axilla. The breast was amputated one month later.

Description of Specimen (*Fig.* 28).—The breast contains a number of cysts measuring from ½ in. to 2 in. in diameter, with thick fibrous walls. Two of the largest communicate by wide apertures with the surface. The cysts in every instance show a number of white, cauliflower-like nodules of tumour-tissue sprouting from their walls, and in three the entire space is occupied by these masses of growth. Otherwise the cyst walls are perfectly smooth inside, and on transverse section they show a narrow inner layer of white fibrous tissue, and an outer broader zone of a rich-brown colour, due to the presence of iron-containing pigment. Immediately adjacent to some of the cysts there are circumscribed solid areas, showing a mixture of the same rich-red tissue with yellowish, glistening patches of cholesterin and lipoid deposit.

Fig. 28.—*Case* 1. Slice from the centre of the breast, showing cysts with papilliferous carcinomatous masses sprouting from the walls. The cholesterin-bearing portions are the solid dark areas adjacent to the cysts.

The whole breast lesion is sharply defined at the margin, being apparently encapsuled by fibrous tissue. The nipple is retracted, owing to involvement of the deeper parts of the galactophorous ducts.

Histology.—The solid white masses which project into all the cysts are composed of active, cellular, adeno-papillomatous tissue, with abundant evidence of malignancy in the form of solid, spheroidal-celled carcinomatous areas here and there. The histology of the cholesterin-containing areas will be described in conjunction with those of *Case* 2.

After-History.—The patient, now in her 80th year, was visited a few weeks ago, seventeen years after the operation. She was found to be in good health, with a well-healed linear scar over the left side of the chest.

Case 2.—(1903.)

Clinical History.—The patient was a married woman, age 60, who had borne no children. She first began to have pain in the left breast at the age of 34, and this, together with an intermittent serous or blood-stained discharge from the nipple, continued for about seven years. The discharge then ceased, and for the ensuing nineteen or twenty years there was a slowly progressive enlargement of the affected organ. During this time the general health remained good; but in the summer of 1903 she began to be alarmed lest she might be suffering from cancer, and in consequence became worried and ill. She finally consulted her doctor in November of the same year, and a diagnosis of cystic tumour, probably non-malignant, was made. The breast was amputated on November 7, 1903, and she made an excellent recovery.

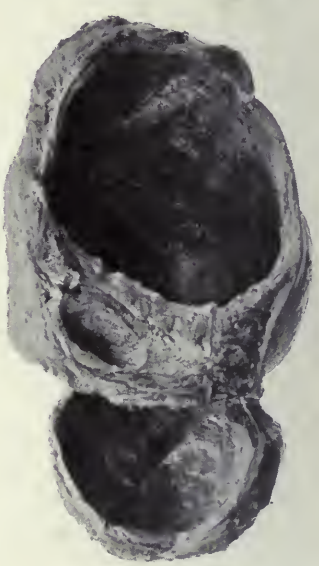

Fig. 29.—*Case* 2. Two large thick-walled cysts are seen, with one smaller one between. The speckling of the interior of the cysts is due to deposits of cholesterin.

Description of Specimen (*Fig.* 29).—The breast is very greatly enlarged, and is occupied by two large cysts with an intervening small one. These measure roughly 6 in. × 6 in., 4 in. × 2 in., and 1¼ in. × ½ in. Each cyst presents a rough lining, and the largest shows a number of slightly raised, glistening white nodules of cholesterin deposit. The cyst walls are much thickened, of a dark-brown colour, and speckled all over the cut surface with small glistening deposits of cholesterin crystals. There are no papillomatous in-growths like those seen in *Case* 1, and no normal breast tissue can be determined. The skin of the breast is stretched out over the cysts, and the nipple is flattened out rather than retracted.

Histology.—The microscopic structure of the walls of the cysts is very similar to that of the brown, cholesterin-containing areas in *Case* 1, and the same description will serve for both.

After-history.—The patient is now 76 years old, and in good health. There is a linear cicatrix at the site of the old operation.

MICROSCOPIC STRUCTURE OF THE CHOLESTERIN-BEARING AREAS.

In paraffin sections the salient feature of the microscopic structure of these areas is the enormous aggregation of 'cholesterin clefts'—that is, spaces from which tabular crystals of cholesterin have been dissolved out in the process of paraffin embedding. In *Case* 2 these are arranged in groups, of which the individual clefts, lying parallel to one another, are often not clearly differentiated (*Fig.* 30). The different groups show similar orientation in certain fields only. In *Case* 1 the clefts are much more sharply defined, and, while still remaining roughly parallel, have assumed a curious pennate arrangement, with nothing like the same separation into distinct groups (*Fig.* 31). In both cases, but especially in *Case* 2, the fibrocellular stroma separating the groups of clefts contains large numbers of foreign-body giant cells. They lie in close relation to the clefts, which are in fact largely separated from one another by their fine cytoplasmic prolongations. In some fields large masses of clefts appear to be embedded simply in homogeneous necrotic material or granular débris, often with a large number of red blood-corpuscles in the stroma, or free in the clefts. Elsewhere the septa between the clefts are composed of flattened nucleated cells, probably of endothelial origin, and here again many effused red cells may be present. The stroma also contains varying numbers of large endothelial cells with foamy cytoplasm, especially at the periphery of the cholesterin-bearing areas (*Fig.* 32), where they occur in large masses. Many of these cells contain granules of yellowish pigment, some of which give the Prussian-blue reaction. In certain areas the clefts are fewer in number and more discrete (*Fig.* 32), and foreign-body giant cells and foamy cells are then seen in greater profusion. The cholesterin-bearing areas are bounded at the margin by a more or less definite wall of dense fibrous tissue, here and there by cellular granulation tissue.

FIG. 30.—*Case* 2. (Low power.) Note arrangement of clefts in groups. Large foreign-body giant cells are seen in the matrix.

FIG. 31.—*Case* 1. (Low power.) Innumerable cholesterin clefts are seen, arranged in a somewhat pennate fashion.

In frozen sections the masses and groups of tabular cholesterin crystals are very conspicuous, and their optical activity is demonstrated by the use of the polarizing microscope. They give the characteristic microchemical reactions of cholesterin, assuming a rose-pink colour when strong sulphuric acid is run under the cover-slip, and a violet colour, followed by green, and finally black, on the subsequent application of Lugol's iodine. In sections stained with scarlet-R, the foamy cells of the stroma are seen to

be filled with orange-coloured granules and globules, while they take on a violet tint with Nile-blue sulphate-A. In association with them are numerous fine acicular crystals, apparently mainly extracellular, but also in part intracellular, which are also optically active. Exposure to temperatures up to 100° C. has no effect on the large tabular variety (i.e., more or less pure cholesterin), but the acicular crystals are dissolved, mainly at temperatures below 60°. On cooling they assume the form of anisotropic globules (fluid crystals), and are doubtless either compounds or loose combinations of cholesterin and fatty acids. It is found that exposure to 100° C. causes the liquefied crystals to flow together, and so to form, on cooling, anisotropic globules of much larger size than if the section had been heated to 60° C. only.

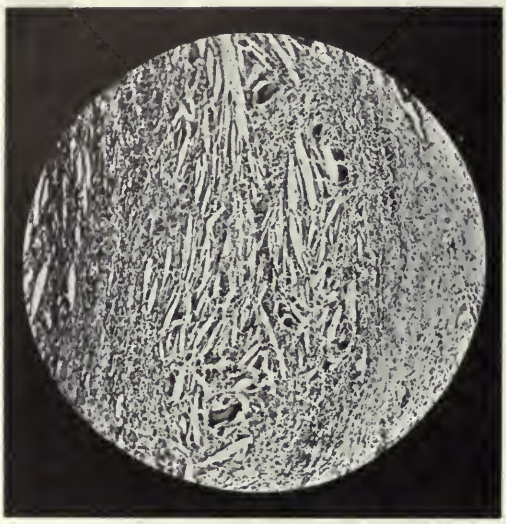

FIG. 32.—*Case* 1. (Low power.) Marginal zone of cholesterin deposit, showing large foreign-body giant cells. The pale area to the right of the field is extensively infiltrated by foamy cells.

OBSERVATIONS.

The condition here described, of the deposition in the breast of very large amounts of plate cholesterin, is doubtless merely an exaggeration of a process already familiar. The causative factors at work are some of those usually associated with such deposition, viz., the accumulation *in situ* of necrotic tissue, effused blood, glandular secretion, and inflammatory exudate. In the proeess of disintegration of these substances the more soluble constituents are absorbed, while the less soluble, such as cholesterin and the hæmatogenous pigments, remain in the tissues.

The original lesion in both instances was undoubtedly a mastitis, probably subacute, with acute exacerbations, and in both the condition was of very long standing. In *Case* 1 the affected breast had been the seat of an acute suppurative mastitis thirty-five years previously, but this apparently healed up, and the actual duration of symptoms prior to operation was ten years. There was a slowly-growing mass in the breast, and an intermittent discharge of blood and pus from the nipple. In *Case* 2 the duration of symptoms was no less than twenty-seven years : during the first seven years an intermittent serous or bloody discharge from the nipple, and then a slowly progressive enlargement of the affected breast for about twenty years.

The chief factor accounting for the large size of the cholesterin deposits is obviously the long continuance of the pathological processes concerned. An intermittent discharge of serous or purulent material from the nipple probably implies some degree of intermittent retention of these exudates in the intervals, and this continued for ten years and seven years respectively in the two cases. In *Case* 2, where there is enormous cystic distention with very abundant deposition of cholesterin in the walls, there is also a history of gradual swelling of the breast for twenty years after the discharge from the nipple had ceased.

That there must have been a great deal of hæmorrhagic extravasation into the lesions, probably also intermittent, is shown by the presence of large amounts of hæmatogenous pigment as well as of recently-effused blood.

SUMMARY.

1. The cases described are instances of long-standing subacute mastitis where, owing to retention of necrotic débris, inflammatory exudate, glandular secretion, and effused blood over long periods, very extensive deposition of crystalline cholesterin has taken place.

2. The histological appearances in paraffin sections are most striking and characteristic, consisting of an enormous number of clefts, lying parallel to one another in large groups, or arranged in a pennate fashion. The crystals occupying these clefts have the optical and microchemical characteristics of cholesterin. The intervening stroma contains foreign-body giant cells in large numbers, and many 'foamy' endothelial cells, especially round the periphery of the main deposits. The foamy-cell areas contain in addition a large amount of acicular crystalline material which melts at temperatures well below 100° C., and which forms anisotropic globules on cooling (i.e., compounds or combinations of cholesterin and fatty acids).

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TRAP-DOOR OPERATION FOR EMPYEMA.

By A. N. McGREGOR, Glasgow.

This operation is devised to provide an outlet for the pus of empyema without the use of a tube, by means of a positive pump action which ensures that the pleural cavity is emptied in a very short space of time and the lung brought down to its normal position.

Tubes as a means of affording outlet for purulent fluid have been used for very many years, and are still necessary in certain situations. Their obvious defects are that, by keeping the orifice patent, they are apt to allow of the ingress of air and secondary infections, particularly when they are used in the chest or abdomen. While an ordinary pneumococcic pyothorax may dry up under this treatment in a reasonably short time, it is a common experience that a long period of drainage is required, and in some cases the more serious operation of thoracoplasty follows. It will be obvious that in draining by a tube the influence of gravity is the main factor after the tension or pressure of the over-distended pleura ceases, and at this stage the movements of inspiration and expiration have the alternate effects of sucking in and expelling the contents of the tube. The pleural cavity now contains not only pus but air. The lung content does not descend rapidly, and the unoccupied portion continues to produce pus.

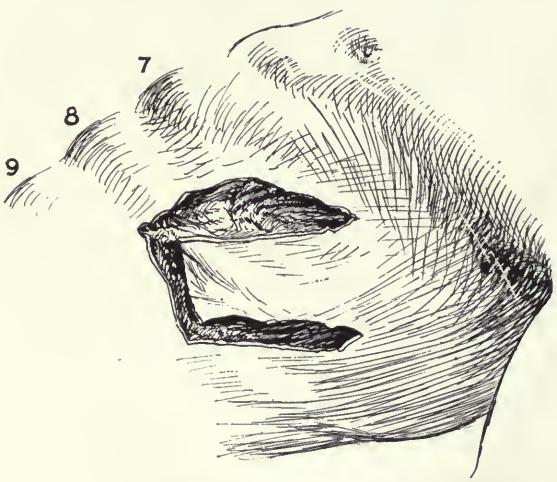

Fig. 33.—To show the position of the rectangular incision.

The object of the procedure now advocated is to provide a flap, rectangular in shape, composed of the whole thickness of the chest wall down to the level of the ribs, and to provide an opening by resection of part of a rib opposite the centre of that flap, so that the pus leaves the chest cavity under the flap during expiration, and the movement of inspiration sucks the flap against the opening, and so prevents the entrance of air.

The following are the steps of the operation :—

Site.—The most suitable position is in the axillary line at the level of the 8th rib, but it is sometimes preferable, in emaciated people, to operate more posteriorly near the erector spinæ in order to get a thicker flap.

Incision.—The size of the rectangular incision should be governed by that of the patient, and the most convenient guide is to measure from the upper border of the 7th to the lower border of the 9th rib for the vertical portions, and a like distance should separate the lower ends of these incisions (*Fig.* 33). The whole of this flap is reflected upwards so as to expose the ribs, and it is kept in that position by an assistant during the next stage of the operation.

The periosteum of the 8th rib is now incised for a distance of one to two inches,

depending upon the size of the individual. This incision is parallel to the long axis of the rib, and a transverse incision is made at the anterior and posterior ends. By means of a periosteal elevator the periosteum is removed from this section of bone, both on its outer and inner aspects (*Fig.* 34). The bare bone is then removed by means of suitable bone forceps. Sometimes gouge forceps are found to be specially useful for this purpose, particularly in the very young.

There now remain but periosteum and pleura, which should be kept intact up to this point.

The traction forceps are now taken off, and the flap is brought down to its original position. A suture is inserted in each corner of the flap and the corresponding corner of

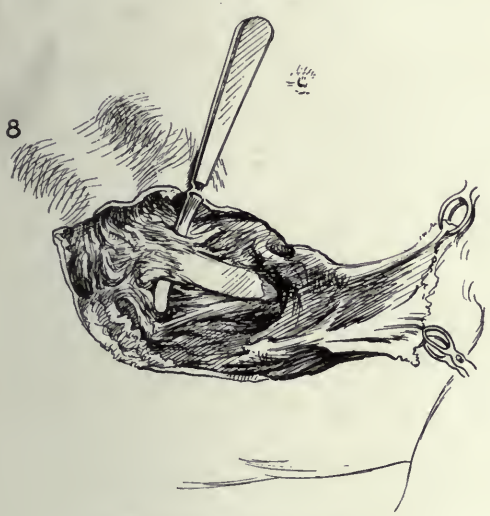

FIG. 34.—Removing the periosteum.

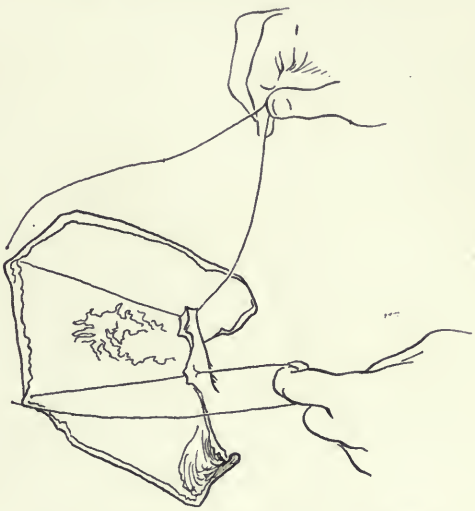

FIG. 35.—Position of the sutures as held by the assistant.

the wound, taking the whole thickness of the flap and a like amount of the adjacent tissues. These two sutures should be long, preferably of silkworm-gut or silk, and the assistant should hold the loose ends with a slight degree of tension while the surgeon performs the last stage of the operation (*Fig.* 35).

This final step consists in raising the lower border of the flap until the gap in the

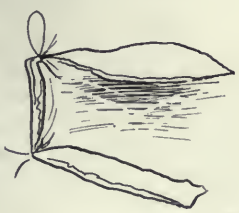

FIG. 36.—Showing flap in position.

FIG. 37.—Showing relative position of flap, removed rib, and incision into pleura.

8th rib is visible, incising periosteum and pleura there with one rapid cut of the knife, and immediately lowering the flap and holding it in position until the assistant has tied the two sutures (*Fig.* 36).

Fig. 37 is a diagrammatic representation of the relative positions of the flap, the removed portion of rib, and the incision into the pleura.

The pus will now ooze out underneath the flap during expiration, and on inspiration a depression of the flap will be seen next the opening of the chest wall. There will be no forcible ejection of pus or inspiration of cold air, and consequently there is a marked absence of cough. The pus is pumped out at a fairly rapid rate during the first ten minutes, and afterwards in smaller and diminishing quantities, until it finally ceases in a period varying from three to ten days. When the discharge has ceased, the sides of the flap may be sutured.

The dressings employed are fairly bulky, and composed of gauze, cellulose, and cotton-wool; they are changed as soon as they are felt to be moist.

This operation was devised about 1912, and was used on many occasions prior to the outbreak of war. Practical experience has enabled many improvements to be made, so that during active service, and since, the procedure above noted has been stabilized, and may be considered well beyond the experimental stage.

Perhaps the most gratifying feature is the quick descent of the lung to its normal situation, which has been frequently verified by auscultation the day after operation. In this connection, however, a word of warning may be offered. In old-standing cases, particularly in the aged, and in those arising out of tuberculous disease where pleural adhesions are likely to have formed, the forceful pump-like action might readily tear these adhesions and cause hæmorrhage or pneumothorax.

Anæsthesia.—In a number of cases it was not possible for the patient to assume the recumbent position, and so the commoner general anæsthetics were impracticable. The operations were performed with the patient in the sitting position, occasionally with ethyl chloride or gas and oxygen, more frequently by means of infiltration local anæsthesia. In this last a very weak solution should be used over a large area, and when the flap is reseeted a further dose should be injected under the periosteum, and in the intercostal spaces above and below the section of rib to be removed. A 1 per cent solution of cocaine in normal saline solution, with 10 minims to the ounce of adrenalin hydrochlor. (1–1000), forms a useful and efficient mixture.

In three cases the patient's condition was so extreme that it was deemed advisable to aspirate some of the fluid before proceeding to the operation. One of these was a case of hæmothorax due to the entry of a piece of shrapnel. When the man arrived in hospital from the convoy he was immediately taken to the theatre, and a fair quantity of fluid blood was removed by the aspirator. Immediately afterwards, under local anæsthesia, the trap-door operation was performed and several pints of blood were removed, in which a fragment of shell was found. Notwithstanding the occurrence of acute nephritis ten days after the operation, the chest condition cleared up rapidly, and the patient eventually made a good recovery.

Quite recently a patient was admitted to the Glasgow Royal Infirmary whose condition was considered inoperable until the intrathoracic pressure was relieved by aspiration. Following are the details :—

Patient, male, age 11, admitted on Feb. 18, 1920, suffering from left pyothorax. Ailment of five weeks' duration. On admission, the pulse was 120, temperature 100·8°, and respirations 52. Patient was very weak and emaciated, and was unable even to sit up in bed. There was a slight flush over the malar prominences, and circumoral pallor. Dyspnœa was marked; the intercostals of the right side and the alæ nasi were moving rapidly. The chest was asymmetrical, the left side being slightly bulged and the intercostal spaces indistinguishable from the rib curves. The apex beat was in the 3rd right intercostal space, almost in the right nipple line.

On palpation, the left side of the chest was not moving with respiration. No vocal fremitus was felt. On percussion, the whole of the left side of the chest was dull. The cardiac dullness extended one inch to the right of the right nipple. On auscultation, the cardiac and pulmonary conditions were substantiated.

The patient was too ill for radical operation, and therefore 52 ounces of thick foul-smelling pus were aspirated. Next day the trap-door operation was performed and about 2½ pints of pus were evacuated.

Progress was uneventful. Discharge had practically ceased by March 2, and patient was fit for dismissal on March 18.

In conclusion, it may be stated that this operation is a means by which a flap of soft parts sufficient to cover the opening in the chest-wall is employed to prevent the entrance of air during inspiration, but so loosely sutured as to allow of the expulsion of pus during expiration, thus utilizing the ordinary respiratory movements to provide the power of the pump.

It is important to note that the flap should be ample, so that its edges may not be drawn into the opening in the chest wall. In the earlier stages circular and oval flaps were tried, but for the last five years the rectangular shape has been found the most satisfactory.

I have to thank Mr. A. J. Couper for much valuable assistance during the practical application of the principles of this procedure, and I am especially indebted to Mr. F. A. Farrell for the accompanying diagrams.

THE TREATMENT OF TUMOURS BY RADIUM AND X RAYS.

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Report to the Vth International Congress of Surgery, Paris, 1920.

In the treatment of malignant tumours we have to consider: (I) *The action of radiations on tumours;* (II) *The forms of tumour for which radiation should be used;* (III) *The type of radiation to be used;* (IV) *When and by what method it should be applied;* (V) *After-effects of radiation treatment, and how to avoid or minimize them.*

I. THE ACTION OF RADIATIONS ON TUMOURS.

When the radiations, either of radium or *x* rays, are applied to the tissues, they will, if a sufficient dose be given, cause a destructive effect. Fortunately, however, the dose requisite to produce destruction is very different for different types of cell, and in many malignant tumours the dose required to kill the tumour cell is only a small fraction of that which destroys healthy tissues. The different types of healthy cell vary considerably in their sensitiveness to radiations, but a particular type in a particular part of the body has always approximately the same sensitiveness. Thus glandular tissue is more sensitive to the rays than epithelium, and epithelium more than muscle, but the epithelium of the tongue is more sensitive than that of the skin, and much more so than that of the vagina.

The different growths also vary much in their sensitiveness to the radiations; but, with certain limitations referred to later, each tumour has its own characteristic response according to its type, situation, and stage of development. The same type of cell will respond somewhat differently to different types of radiation, and this will be discussed when considering which radiation to use.

What we aim at in the radiation treatment of malignant disease is extirpation of the growth *in situ* without destruction of the surrounding tissues. This latter must be avoided as far as possible, since it impairs the efficiency of the result by preventing the healthy tissues from dealing effectively with what remains of the growth, by delaying healing, by rendering the part more prone to sepsis, by causing pain and absorption of toxic material, and, more important, by preventing subsequent irradiation of any tumour cells which have not received a lethal dose of rays, and this is not infrequently the case. It is at present not possible to say whether the irradiation of the surrounding tissues stimulates them to resist the invasion of a growth: a dose considerably below that which would cause damage would probably stimulate them.

There is another object in the irradiation treatment of tumours. It has been shown, by experiments on mice, that a tumour which has been removed from the body and then exposed to a sufficient dose of radium or *x* rays, cannot be implanted into another mouse. Further, if the irradiation is just sufficient to inhibit the growth of the tumour and no more, a degree of immunity is conferred on the animal into which the growth is inoculated; but with a larger dose of rays no such immunity is conferred. It is possible, therefore, to prevent implantation of tumour cells into healthy tissues during an operation by a previous irradiation.

I will refer here to some experiments on minute doses of *x* rays applied to the whole body, carried out at the Middlesex Hospital. It was claimed that a single very small dose of *x* rays produced in rats a great increase of leucocytes, and inhibited or prevented the growth of a tumour subsequently implanted. An examination of the table of experi-

ments, however, shows that in quite a large proportion of the animals experimented on, the growth was not inhibited, and probably the proportion of unsuccessful inoculations is not so much greater than in the controls as to exceed the limits of experimental error. The applications of these experiments to human beings is not recorded. The results, too, are so much against the views derived from clinical experience, that it is a satisfaction to be able to ignore them.

The action of the rays on the same type of tumour is not always the same. There comes a stage in every growth when the rays will no longer differentiate to the same extent, or even will not differentiate at all, between the tumour cells and the healthy cells. In some growths it is earlier and in others later: it is even possible that every growth at some stage would have been curable by radiation treatment. The earlier any type of growth is taken, the more sensitive is it to the rays. Nevertheless, however early a growth is taken, it will vary in its response in accordance with its specific type. This diminution in sensitiveness is usually a slow process, and we know of no means apart from clinical experience of determining the exact time at which irradiation becomes ineffectual. It appears that in some growths a period exists when *x*-ray treatment fails, while radium is still efficacious. When the curable stage of the disease is passed, it is often still possible to obtain relief with radiation treatment.

Can radiation treatment do harm? The answer is in the affirmative; but when it does, bad technique is usually the cause. An insufficient dose applied to a refractory tumour may stimulate its growth.

Excessive treatment will do harm, as already pointed out, and it may also delay healing of a wound in a subsequent operation. There is also the question, especially in irradiating large areas of the body, of the effect of the rays on the other tissues, particularly the leucocytes. We know comparatively little at present of the effects of large quantities of radiation upon the blood, and it might be possible to damage the patient's resistance to the growth. In ordinary doses this does not appear to occur. Recent work at the Radium Institute of London has shown that *prolonged* exposure to small doses of γ rays from large quantities of radium results in marked leucopenia. It is pretty well established that the irradiation and absorption of one metastasis will exert a beneficial effect on a distant one, but the actual disappearance of a non-irradiated metastasis as the result of irradiating the primary growth or another metastasis has not been recorded.

It will now be obvious that irradiation of a growth may be used for several purposes.

1. **Prevention of Inoculation of Tumour Cells into a Wound** at a subsequent operation, or when a piece is removed for microscopical examination.

There is no doubt that irradiation should be much more widely used than it is at present for this purpose. In any case where it is possible that the growth might be of a type sensitive to *x* rays, this method should be used. Naturally, in a growth of a type obviously unsuitable for irradiation, it should not be employed, as it might lead to stimulation of the growth. An instance of this is the usual infiltrating type of epithelioma of the tongue.

In the surgical extirpation of a tumour the surgeon must of necessity often cut through tissues which contain elements of neoplasm, possibly microscopical: at the same time the lymphatic spaces are opened and these elements become implanted in the tissues around. Results show that local recurrences are frequent. Now, if these cells are rendered unimplantable, local recurrence can only occur from tumour cells actually left behind which have not received a sufficient dose of irradiation, and the possibility of these should be dealt with by subsequent prophylactic treatment.

The practice of cutting into a growth to remove a portion for microscopical examination may lead to widespread dissemination if the tissues have not previously been irradiated. Provided the section is made within two or three days after the irradiation, no alteration in the structure of the growth can be detected, and consequently the microscopical diagnosis is not interfered with.

Care must be taken not to damage the skin in irradiating; otherwise healing will be delayed. Operation can be carried out at any time during the fortnight following the

irradiation: it is better not to attempt it during the reaction period which occurs in the third week following the irradiation; nevertheless, if circumstances demand it, an operation in this period is not contra-indicated.

2. **Destruction of the Growth** *in situ*.—This is used in the types of tumour which respond most readily to radiation treatment, also when more resistant types are treated in inoperable or in recurrent cases. It can be effected by burying radium in the growth, by using radium rays from outside the skin or inside one of the cavities in the body, by using *x* rays from outside, by opening up the growth and then exposing to *x* rays, or by a combination of these methods. Treatment of recurrences comes under this heading.

3. **Treatment for Relief of Pain and Discomfort.**—Though, in the treatment of growths with the object of producing a cure, we may, as the result of the large doses given, sometimes cause considerable pain, irradiation treatment, as a rule, greatly eases pain; consequently, it is often used for this purpose in quite incurable cases.

Radium is also employed to keep a carcinomatous stricture patent, especially in the œsophagus. Gastrostomy by no means replaces radium in this disease, as it does not relieve the patients' chief discomfort, the quantities of mucus which they continually bring up when there is a tight stricture. In the treatment of a stricture of the rectum, radium may or may not save the patient from a colostomy; in successful cases a fibrous stricture is left which may necessitate bougieing for many years.

Radium is also wonderfully efficacious in stopping hæmorrhage from a growth when this is not from a big vessel, and is sometimes used solely for this purpose even in tumours otherwise refractory to radiations.

4. **To Render Inoperable Growths Operable.**—It is sometimes possible to achieve this object, and if the growth is of a refractory character, it is best to seize the opportunity rather than rely on continuing irradiation. The rapidity with which a growth reacts to radiation is a good criterion of its sensitiveness; the quicker the diminution, the more certain the local result.

II. THE FORMS OF TUMOUR FOR WHICH RADIATIONS SHOULD BE USED.

We find that, although there are some notable exceptions, the growths which respond most readily are those which grow the most rapidly. The chief exceptions are, on the one hand, epithelioma of the lip and rodent ulcer—very slow-growing tumours which respond readily; and, on the other hand, epithelioma of the tongue or vulva—rapidly-growing tumours which do not respond to radiations.

The classification at present will be approximately as follows:—

Category A.—**Growths to be Treated by Radiation in preference to Surgery.**—Lymphosarcoma; rodent ulcer.

Category B.—**Growths in which Surgery or Radiation Treatment is optional** (*prophylactic radiation used in either case*).—Endothelioma which has assumed malignant characteristics; epithelioma of the lip; epithelioma of the skin (early stages); the cauliflower non-infiltrating type of epithelioma of the tongue or palate; epithelioma of the penis (ordinary type); carcinoma of the body of the uterus.

Category C.—**Growths for which Surgery is preferred to Radiations, but for which Prophylactic Radiation is used.**—Carcinoma of the breast; carcinoma of the rectum; carcinoma of the ovary; carcinoma of the cervix; epithelioma of the tonsil, floor of the mouth, larynx, pharynx, skin (later stages), anus; spindle-celled sarcoma; alveolar sarcoma; melanotic sarcoma; hypernephroma; glioma.

Category D.—**Growths for which Radiation should not be used.**—Epithelioma of tongue (infiltrating type); epithelioma of vulva.

A. In some growths response is so good that radium or *x* rays must replace surgery. It has long been recognized that radium treatment of rodent ulcer is far and away the most successful, especially if applied before other treatments have been tried and failed. In these cases, if rightly employed, success should be obtained in more than 95 per cent of cases, and probably in more than 99 per cent.

We have now to claim another type of tumour from the hands of the surgeon—lymphosarcoma. I have for many years held the view, and increase of experience confirms it, that this disease should never be treated by surgery except to insert radium into the tumour. It is a rapidly-growing tumour and, unfortunately, too much time is usually lost before the radiologist is called in; then the patient shows general metastases in the lungs, the liver, and elsewhere. This particular type of growth is so susceptible to radiations that even metastases may be treated so long as they are not too widespread.

Example.—I was called to see a patient in 1913 who had a large mass in his right groin about 10 to 13 cm. in diameter, a still bigger mass in his right iliac fossa, and a mass in the right lobe of his liver; a scar on the forehead which he had had for many years had recently become much thickened and very red, and it is quite possible that this was the source of the disease. Unfortunately, no section was made of the growth, but the clinical appearances and the subsequent course of the case left no doubt in the minds of those who saw it that it was a lymphosarcoma. The scar on the face was treated with filtered radium rays, and the rest of the disease by intensive doses of filtered *x* rays. Improvement was striking and rapid, but treatment was continued many months after all obvious signs of the disease had gone. Some months after treatment had ceased, he developed a late *x*-ray reaction which, however, we were able to preserve from ulcerating. The next event was that he joined the army early in the war, and rose rapidly from the rank of private to that of major. In the course of this procedure, he received a fairly severe wound in the leg, in 1915. In 1916, rather more than three years after the disappearance of the original growth, he had a recurrence in the *left* side of the neck. Intensive *x*-ray treatment of the neck and the mediastinum got rid of this, and he remained free from trouble until 1919, when he developed great pain in the back and left side, and when at last we got the army authorities to send him back from Cologne we found that he had a recurrence in the spleen. A short course of intensive *x*-ray treatment got rid of this, and when I last heard from him he was quite well.

Dominici showed a case years ago in which we had treated successfully several large recurrences of a sarcoma of the testicle, one being a great mass in the lumbar region.

B. We do not yet claim, as a right, any other forms of *operable* tumours, though there are some in which the patient might be given the option. For instance, endothelioma responds so well that a patient who demanded radiation treatment in preference to operation would not be unreasonable. When I say endothelioma, I mean the type commonly recognized as such, and not that which some pathologists call endothelioma and others epithelioma. The commonest situations of the true type are, of course, the parotid and the palate.

Carcinoma of the *body* of the uterus is another type where the treatment might perhaps be optional, but surgery is very successful in most of these cases. With the employment of larger quantities of radium, and with its use in earlier cases, and their more thorough after-treatment, we are likely to have to bring a much larger number of cases into this or into the first category in the near future. For instance, in several clinics radium is already being used as the treatment of choice in carcinoma of the cervix, a disease which, in its later inoperable stages, is only moderately susceptible to the radiations.

The earlier treatment by radiations of carcinoma of the rectum, and of epithelioma of the tonsil, pharynx, bladder, or skin, combined with improved methods of treating these cases, such as by embedding the radium aseptically into the growth or even into the tissues around it, seems likely also to result in a modification of the views at present held about them.

Epithelioma of the lip can be very successfully treated with radium, and consequently falls into the category of cases in which the patient should have the option of radiation treatment.

C. The third category consists of cases which are more refractory to radiation treatment, and where an operation is advised whenever possible. The question of pre-operative and post-operative radiation depends on the susceptibility of the particular type of growth. Carcinoma of the breast, for instance, does not react readily enough to advise radiation treatment alone, so that one always recommends operation where possible: nevertheless recurrences of this tumour may be cured with radiations, and therefore one should be able to cure a certain number of primary growths; long and continued treatment, however, is necessary. Obviously, therefore, the best method is to get these cases early, treat them

prophylactically with radiations, and operate as completely and thoroughly as if no radiation treatment were being used. This category contains a very large proportion of the total number of cases, owing to carcinoma of the breast and of the rectum being included in it. Epithelioma of the cheek and of the floor of the mouth might also be placed under this heading, but they are more refractory than the others mentioned. When growths in this category are inoperable, or when operation is contra-indicated for some other reason, they should be treated by radiations, especially the more susceptible types.

D. The fourth category includes cases which are so refractory to radiations that one risks exciting them to increased activity by giving insufficient doses to the outlying parts. Such growths are the infiltrating epithelioma of the tongue and the ordinary type of epithelioma of the vulva. Radiations must sometimes be used in these cases for the relief of pain or hæmorrhage.

Inoperable growths in *Categories B* and *C*, or cases in these categories in which, for some reason, operation is contra-indicated, will, of course, be treated by radiation, and in these will be included carcinoma of the œsophagus.

III. THE TYPE OF RADIATION TO BE USED.

Physicists tell us that it does not matter what radiation we use so long as the amount absorbed by the tissue irradiated is the same. Practical clinical results do not confirm this. In my experience, and I believe that the majority of radiologists agree with me, the more penetrating the radiation the more satisfactory the results. It may be that the more penetrating radiations permit of greater doses being applied to the tumour without damaging the skin ; but the amount of radiation absorbed when using the γ rays of radium must be infinitesimal, and yet this appears to be the more useful radiation even for the most superficial growths if one can get it in sufficient quantity ; when using radium, however, this is the difficulty. Some experiments were conducted at the Middlesex Hospital, London, during the winter, but at the time of writing they are incomplete. Five grams of radium bromide were used, and all the applications were external. Some of the cases I saw being treated in this way I should consider quite unsuitable for radium treatment in any form. An attempt is being made to confine the treatment to one single dose, though of course this sometimes needs to be subdivided into two applications : this in itself will prevent the results being as good as one might otherwise expect, as clinical experience has shown how necessary it is to give several doses, including prophylactic radiations. I hope to give some later information as to these experiments by the time of the Congress.

Experiments conducted at the Middlesex Hospital with comparatively small and comparatively large quantities of radium have shown that when a tube is inserted into the anus of a rat so that it lies partly against the squamous and partly against the columnar epithelium, using the same dose in millicurie-hours, a small quantity for a long time has more effect in destroying squamous epithelium, while the reverse obtains with columnar epithelium. I am told this experiment can be repeated time after time ; I should, however, like to see it confirmed by the use of another pair of tubes constructed on similar lines and with a greater difference between the amounts. Can these experiments be taken into account in the treatment of tumours ? I think not. The epithelial cells found in an epithelioma are not normal, and do not behave like normal epithelial cells. The matter has not yet been finally decided, but the results with x rays applied to epithelioma of the tongue have been even worse with small doses applied frequently than with large doses applied seldom.

From what has been stated it will be gathered that radium γ rays are superior to x rays if both can be applied in the same amount. Therefore even for superficial growths the γ rays will be the method of choice. But what about the β rays of radium ? The great work that Dominici did was to show that when a certain thickness of filtration is used—2 or 3 mm. of lead—the results are much better than with less filtration. Dominici thought that hard β rays still got through 3 or 4 mm. of lead, but subsequent

experiments by physicists have shown that practically this is not the case, and that 4 mm. of lead or 2 mm. of platinum is sufficient to cut off approximately all the β rays.

In the treatment of malignant disease, therefore, β rays are not to be recommended. Even in rodent ulcer it is best to filter off the majority of these rays, and I have cases of rodent ulcer where β-ray treatment failed and γ-ray treatment succeeded.

Of the action of the α rays on malignant tumours I have no knowledge: it could be tried by using polonium. Their penetration is so small that successful results would not be anticipated.

Unfortunately the quality of the radiation is not the only problem we have to consider. Our chief difficulty is to drench the tissues most distant from the source of the rays with a dose sufficient to destroy any elements of growth without exerting a destructive effect on normal tissues which are nearer to the source. Now it is found much easier to do this with heavily-filtered *x* rays than with the small quantities of radium ordinarily in use (I refer to 100 to 300 mgrm. as a small quantity). Nevertheless, I believe that massive doses of radium irradiation applied in a similar way to *x* rays would give better results.

My observations lead me to disagree with the theory that some growths are more sensitive to radium and others to *x* rays; I believe that all are more sensitive to γ rays of radium, but it is a question of the accessibility and distance of the furthest tumour cells. Take a common case, a recurrence in the skin in a case of carcinoma of the breast which has been operated on but not treated prophylactically. We know that radium will get rid of it much more easily and quickly than *x* rays; notwithstanding this we employ filtered *x* rays, because there are certain to be other elements of growth left behind in other parts of the pectoral, axillary, or clavicular regions. Or again, take a case of lymphadenoma or lymphosarcoma of the neck. We know that we can get a locally successful result with radium more quickly than with *x* rays; but the treatment we recommend, even if radium is used, is *x* rays as a preliminary, to prevent implantation or metastases when the radium is subsequently buried in the growth; then radium treatment followed by *x*-ray treatment to destroy the most outlying portions of the growth. In some cases the radium is not even necessary, as they react so well to *x* rays, but this will depend on the type of case.

Example.—I saw a patient, in 1914, with a sarcoma of the tongue and huge masses of glands in the right side of the neck, enough to cause complete paralysis of the phrenic nerve. There were also enlarged glands in the left side of the neck, and probably in the mediastinum. A preliminary irradiation was given to the neck; a few days later a 100-mgrm. radium tube with a 2-mm. platinum filter was inserted into the tongue by the aseptic route, i.e., through the median raphe. Filtered-*x*-ray treatment of both sides of the neck and chest was continued for six months. The patient remains well six years after the treatment was commenced.

With a comparatively limited growth such as a sarcoma of the muscles of a limb, where we can apply the radium at different points on the circumference, it may be possible to carry out the prophylactic treatment by radium, and then one should give two treatments after the growth can no longer be detected by manual examination.

Filtration in radium treatment cuts out the α and β, and the soft γ rays; in *x*-ray treatment it cuts out the rays of longer wave-length, the less penetrating rays. In treating tumours which are quite superficial, we filter both radium and *x* rays just the same. The reason for doing this is chiefly that we increase the relative difference of the action of the rays on healthy and tumour cells. The fact that we also diminish the amount of radiation absorbed in the superficial layers, so that the depths receive a greater quantity, is important; but it is insignificant compared with the other effect. This cannot be too strongly insisted on, as the results of treatment by filtered radiations, even in the most superficial growths, are incomparably superior to those obtained by unfiltered rays; one may even convert failure into success by using thicker filters. The amount of filtration or screening to be used is not yet finally determined.

In radium treatment, 0·5 mm. of platinum or 1 mm. of lead or silver suffices for most rodent ulcers, but occasionally one has to use more. For other growths I consider that 2 mm. of platinum or 4 mm. of lead or silver are necessary; some substance must be used to absorb the secondary radiations, even when the radium is buried. For *x* rays, 3½ mm.

of aluminium are the minimum, and probably 5 or even 10 mm. are better. Pure aluminium is the best substance to use for filtering *x* rays, as any secondary rays from it will be absorbed by a few centimetres of air if this space be left between the filter and the patient's skin. It has the additional advantage that it is not bulky, and the dose can be measured after it has passed through the filter.

In filtering radium rays the thickness of aluminium required would be enormous; therefore, to get the filter into the smallest possible compass we use the densest workable metal obtainable, and this is platinum. The secondary radiations may be filtered off by a sheath of rubber or a thin layer of aluminium.

IV. WHEN, AND BY WHAT METHOD, RADIATION SHOULD BE APPLIED.

1. **In Treating Growths by Radiation Only.**—It is almost superfluous to point out that the earlier the case is treated, the greater will be the probability of a successful result. Surgeons have long insisted on this with regard to operation, but they seem to forget that it applies as much or even more to radiation treatment. A stage occurs in every malignant growth when it no longer responds to treatment by rays. Successive doses of rays seem in some cases to exert less and less effect; but it is possible that this is only because it is a later stage in the course of the disease. There is no object in treating a patient at death's door with rays; it merely provides material for ignorant critics of irradiation treatment. There is perhaps an exception to this statement. I have seen patients with lymphosarcoma who have been dragged back to life when almost at their last gasp, and who have lived for months or even years.

The next great truth is that we have not yet arrived at such perfection of technique as to be able to treat cases with one dose only. It is true one may have an occasional success if one does this, but the number of curable cases which will be lost will be most disheartening. The irradiations must be repeated for some time after all clinical signs of the disease have gone. In using radium rays I try to give two applications after the patient is apparently cured. With *x* rays I like to continue for six months after the disappearance of the growth. I find that growths disappear more rapidly under radium than *x*-ray treatment.

Many cases of malignant disease are lost by failing to treat the lymphatics and the glands draining the affected area. This is just as important as in treating such cases surgically. It is not usual to bury radium tubes in these situations, owing to the difficulty of obtaining even action over a large area; they are treated by external irradiation, using radium if possible, *x* rays if not. A combination of radium treatment of the growth and *x*-ray treatment of the glands will sometimes be advisable.

In using radium, the next question is whether it should be buried in the growth or be used from outside. Experience leads more and more to the view that it should be buried whenever possible. After the growth has disappeared, radium should be used from outside, taking care to protect the skin by irradiating from a distance.

A method comparable with burying radium has been used with *x* rays; the growth, having been exposed by a surgical operation, is thoroughly irradiated and the wound closed. I have no experience of this method, but it may be sound for some cases.

In treating a malignant growth attention must always be fixed on the furthest ramifications of the disease, as, unless these be given a lethal dose, the treatment will fail. Any part of the growth which receives an overdose may be disregarded so long as it is kept aseptic. More care must be taken with healthy tissues, but even these will stand much larger doses than the skin if no micro-organisms be allowed to obtain access.

The asepsis required in burying radium or in opening up a growth for *x*-ray treatment is of the most thorough kind. Healthy tissues can stand a big dose of germs without suppuration, but those damaged by rays form an excellent culture medium for quite a small dose. As much attention, then, must be paid to this question as in the most exacting major operations or as in operating on a diabetic.

Radium will be used in preference to *x* rays in every case in which the outskirts of

the tumour are likely to receive a lethal dose of radium rays. In either case the radiations must be well filtered for the reasons already given. With radium it is a good general rule to use sufficient to give the requisite dose in less than two days, though extensive superficial recurrence may sometimes need longer treatment. It will often require all the skill and experience of the radiologist to balance the greater differentiating power of radium rays against the greater ease of flooding the whole growth with irradiation by filtered *x* rays. In the more refractory types of growth, *x* rays fail where radium succeeds, especially in the epitheliomata. There are even cases in *Category B* for which *x* rays are of little value, yet which react readily to radium, e.g., epithelioma of the lip.

The amount of filtration advisable with radium is 2 mm. of platinum or the corresponding amount, 4 mm., of silver or lead. Platinum is usually the best, as it occupies much less space. In treating rodent ulcer 0·5 mm. of platinum will be found sufficient. The secondary radiations from the metal must be cut off, and I believe this to be advisable even when burying the tubes. Burying a tube with an inadequate screen, or one in which the secondary rays are not filtered off, is liable to lead to necrosis even if the operation is aseptic; of course too large a dose of rays might produce the same effect.

The effect of radiations on a septic growth is curious. If the growth reacts readily, the sepsis rapidly clears up; but if the growth is refractory, the sepsis is likely to get much worse. Unfortunately the γ rays have no bactericidal action, and consequently do not improve the condition directly.

The amount of filtration advisable with *x* rays appears to be a minimum of 3·5 or 4 mm. of aluminium. The *x* rays, however, must be 'hard' before passing through the filter.

It is found that with a filter of 3·5 mm. of aluminium most patients can stand a dose of 7 H (Holzknecht units) every three weeks for a long period, and with a filter of 5 mm. they can stand 8 H. My opinion is that a maximal dose given every three weeks is more effective than smaller doses given more frequently. With radium treatment there seems to be even less doubt on this point than with *x* rays. The radium treatments, however, cannot be applied more frequently than every six weeks if maximal doses are given, and their effects are much more lasting than *x* rays.

2. **In Combined Radium and Surgical Treatment.**—In surgical treatment we include not only removal by the knife, but other surgical methods—actual cautery, diathermy, etc. Let no surgeon be lulled into a sense of false security by the fact that radiations are being used in addition to surgery. The best results with tumours in *Category C* (and *B* when surgery is chosen) will be obtained by the most thorough surgical removal combined with the most thorough irradiation. From what has already been said, it will be obvious that the growth should be irradiated before the operation, and the best time to operate is within a fortnight after this. The *x* rays will generally be used in preference to radium, owing to the wide area to be flooded with the rays; but if a very large quantity of radium is available it would be better to employ this. The same filtration and doses should be adopted as in treating tumours without surgery, great care being taken not to damage the skin.

Subsequently to the operation prophylactic treatment must be undertaken. It is not possible to say exactly how many doses should be given. I find that one gets very good results by giving *x*-ray treatment every three weeks for six months, and then a further three months' treatment after a rest of three or four months. Possibly less might suffice, especially for a case in *Category B*, but it is better to continue too long than give too little irradiation.

When treating a case of carcinoma of the breast, or sarcoma of any part of the body, the radiologist will be wise to examine the lungs, and in the former case the mediastinum, by *x* rays. Very often this will prove that what was meant to be a prophylactic treatment is nothing of the sort, but is really treatment for cure or for relief.

Combined treatment has been found an advantage in epithelioma of the tonsil, in which case the glands and the portion of the growth in the neck are treated with radium, while the intra-oral part is best dealt with by diathermy. A word of warning is necessary

here ; for many cases, treated with radiations, do not receive big enough doses. The skin after thorough treatment should become well pigmented, and, after the lapse of two or three years, should usually develop telangiectases. The surgeon must not hold up the results of inefficient irradiation as indicating that radiations in general are not of value.

For the following reasons I am not in favour of removing as much of a growth as possible before inserting radium : (1) The growth forms an excellent medium in which to insert the radium, and though the central parts of the growth will receive an overdose, this will do no harm so long as asepsis is maintained. (2) It is possible that the preliminary irradiation may not have been thorough enough to prevent completely implantation of every part of the tumour. In this case the opening up of lymph spaces may be dangerous. (3) The trauma of a cutting operation followed by that of a radium application often results in severe sloughing, and seems to render the part more than ever liable to sepsis.

I am not in favour, as a rule, of using radium prophylactically by inserting it in the tissues. If employed in this way it is best to wrap the tubes up in a considerable thickness of gauze, and so get a more even action over a larger surface : but it is difficult to flood the suspected area with an efficient dose of rays.

It sometimes happens that an inoperable growth may become operable as a result of radium treatment. If it is in *Category C* it is best to do a thorough operation and follow this by prophylactic treatment. Here I am in favour of prophylactic burying of the radium tubes at the time of the operation, especially if all future close access to the operation area will be cut off by the operation, as in the cervix or rectum.

Example.—A case of a very large inoperable growth of the rectum was treated by radium, with the result that it shrank to half its size and became operable. The abdomino-perineal operation was performed, and radium tubes, enveloped in gauze, were left in both abdominal and perineal wounds. Before the perineal wound closed up, a further prophylactic application was made, and the patient was well when last heard of six years later.

Another aspect of combined radium and surgical treatment is presented when a growth to be treated by radium is in a situation difficult of access. As this usually means a short anæsthetic for the extraction of the tubes as well as a longer one for their insertion, it may be a determining factor in the method of treatment adopted. It is possible to insert radium into such situations as the brain, the base of the skull, the anterior mediastinum, the peritoneum, the prostate, etc. The route of approach must always be an aseptic one. The tongue is approached through the medium raphe, the prostate through the perineum, and the pituitary fossa by the temporal route.

These treatments need courage on the part of both surgeon and patient, especially as more than one must usually be given ; but there is much room for development along these lines by a clean and courageous surgeon. It is advisable, as soon as the growth is reached, to use only blunt instruments ; but a trocar and cannula are sometimes employed, the former being replaced by a radium tube with pointed end. The skin wound should be sewn right up, and the threads attached to the radium tubes buried in the wound; otherwise the micro-organisms will spread along these threads from the skin. Sutures may often be put in double, the one being tied when the tubes are inserted, and the other left until the tubes are removed and then tied.

V. THE AFTER-EFFECTS OF RADIATION TREATMENT.

Irradiation Sickness is one of the troublesome results of deep *x*-ray therapy, especially if the liver or the pelvic organs be irradiated ; but it sometimes occurs with extensive irradiations of other parts of the body, and always if the area treated is sufficiently extensive. The administration of 1 grm. of calcium glycerophosphate three times a day, commencing the day before, and continuing until the day after, the treatment, is sometimes, but not always, effective in preventing or alleviating this condition ; probably the calcium is the active agent. The other method of combating this trouble is to spread each

treatment over two, three, or even four days, repeating the first area treated three weeks from the first day, and so on.

Surface Effects.—If a skin area is treated thoroughly with filtered *x* rays or with radium, a good deal of pigmentation always results. This disappears in time; but one to three years later telangiectases often develop. This is a minor matter, and cannot be taken into account in dealing with malignant disease; but if necessary the telangiectases can be treated by electrolysis after they have fully developed. If a hair-bearing area be treated, such as the skull, it will become permanently epilated.

When treating a tumour through the skin, one must give a dose heavy enough to cause some erythema. With *x* rays this does not usually occur with the first dose. It comes on about sixteen or seventeen days after a subsequent dose, and as a rule lasts only three or four days. It is generally followed by desquamation, but this may also occur without obvious erythema.

With radium the erythema usually comes with the first dose, and, when a 2-mm. platinum filter is used, it is not seen as a rule before fourteen or fifteen days. As the erythema subsides, the skin tends to become covered with an adherent crust of heaped-up epithelium, especially if a thinner filter has been used. A second erythema is occasionally seen about five, six, or even seven weeks after treatment. In all cases I have observed, it has been milder than the first reaction. These skin effects may often be avoided when the radium is buried.

The epithelium of the tongue and palate is more sensitive than the skin, and these parts must be protected whenever possible.

Late Irradiation Effects. — It occasionally happens that one gets what has been called a 'late radium burn' or 'late *x*-ray burn'. I have now seen a number of these cases, and am convinced that they are different forms of infection in tissues damaged by the rays. They occur from one to four years after the commencement of the treatment, and may start any time up to two or three years after its cessation. The late effect may come on during the course of the treatment, if this is prolonged.

There are two main varieties, *acute* and *chronic*. The acute variety commences very like an erysipelas, and spreads rapidly to the whole irradiated area; it is accompanied by rise of temperature and, sometimes, rigors. The whole area becomes acutely tender and much swollen. Unless great care is taken of the damaged part in this stage, it is likely to ulcerate and pass into the chronic form. The treatment is rest and protection of the affected part from any trauma. If the patient must still be irradiated, care must be taken that no rays fall on the affected parts. The only local application advised is a powder of bismuth carbonate, zinc oxide, and starch; antiseptics must not be used.

The chronic variety commences as an ulcer with an indolent surface, very prone to form tough adherent crusts, and this ulcer always has a very bright red edge which is characteristic. This form does not usually spread over the whole irradiated area, and often remains confined to a small surface. The only treatment that appears to be of use is vaccination with autogenous vaccine and protection of the part. Even with this, healing is much delayed. There is no doubt that some profound change takes place in the irradiated tissues after a long period.

TREATMENT OF BENIGN TUMOURS.

1. **Action of the Radiations.**—What has been said about the action in malignant tumours applies in many cases to benign growths also. There are, however, special considerations. Radium rays, both β and γ, but especially the former, have a marked action on the endothelium. The β rays cause considerable swelling of this tissue, a fact which is made use of in the treatment of angioma.

2. **Forms of Benign Tumour to be Treated, and the Type of Radiation to Employ.**—

Angioma.—All angiomatous tumours respond to radium treatment. The spider nævus, for which electrolysis is more suitable, can hardly be called a tumour. There

is no method which leaves so little scar as radium in these nævi. If the tumour involves the actual skin a mark is bound to be left, but even then it is much less than that produced by carbon-dioxide snow or electrolysis.

The penetrating β rays are the best for this condition. The γ rays cannot be excluded ; but as they have in themselves a beneficial action on these growths they do no harm. The best results are obtained by screening with 0·1 mm. to 1 mm. of lead, or 0·05 to 0·5 of platinum. Even entirely subcutaneous growths rapidly disappear after external treatment when the higher filtration is used. The technique in these cases requires much experience and careful management, the general rule being to go slowly and wait a long time for results, as the cases continue to improve for six months or a year after the treatments.

Lymphangioma.—This rare disease is also favourably influenced by irradiation. Under this heading we might include the rare cases of congenital lymphatic hypertrophy of the tongue.

Here again the β rays will be useful ; but a filter of at least 0·5 mm. of platinum will be required, as these growths are generally extensive and infiltrating. The same treatment is used in the congenital lymphatic hypertrophies.

Keloid.—This tumour responds both to radium and *x* rays, but it is more refractory than angioma or papilloma, so that care must be taken not to push the treatment far enough to obtain telangiectases.

Either β or γ rays may be used. I usually employ a filter of 0·5 mm. of platinum.

Fibromyoma of the Uterus.—In recent years much has been written about the treatment of this condition with rays, and it has come to be recognized that a patient over 38 should often be allowed the option between this and operation, while in some cases ray treatment will be preferred. In younger patients irradiation is not so certain in its results or so free from after-effects.

Penetrating radium rays may be used by inserting tubes with a 2-mm. platinum filter in the uterus. This method usually acts more quickly than *x* rays, but it necessitates dilatation of the cervix, which is best done by dilators under an anæsthetic ; a tent may be used, but is not recommended. *X* rays filtered through at least 3½ mm. of aluminium may be applied externally, as described later.

In most of the other benign mesoblastic growths radiations have little or no effect.

Papilloma, including *Warts* and *Corns.*—These are very amenable to treatment by radium, and, to a lesser degree, by *x* rays. Gonorrhœal warts are included in this series. The absence of scarring in this group of cases is often very striking.

For papillomata radium is best, with a filter of 0·5 mm. platinum or its equivalent. If radium is not available, *x* rays are a fairly satisfactory substitute, filtered rays being used in full doses.

Exophthalmic Goitre.—Success is obtained in so large a proportion of these cases that irradiation has come to be regarded as the treatment of choice. Great care must be taken, when using *x* rays or external applications of radium, not to give full doses, otherwise telangiectases will result ; and, unless the case is a desperate one, it is hardly justifiable to produce them. Burying radium avoids this.

Treated externally there seems little advantage in the use of radium over *x* rays, except the fact that a larger dose of rays can be given without the subsequent development of telangiectases. If the patient's condition permits of burial of radium tubes in the thyroid, this is undoubtedly the treatment to be administered. Insufficient data are available to indicate the most suitable filter. From *x*-ray treatment successful results have been obtained with a 2-mm. aluminium filter, but 3·5 mm. is better.

Parenchymatous Goitre.—Some of these tumours can be markedly diminished by radium treatment, but they are rather refractory. Radium should be used, tubes being buried in the thyroid for preference.

3. **When, and by what Method, the Radiations should be Applied.**—In benign growths the stage of the disease is not so important usually as in malignant growths. Exophthalmic goitre is perhaps an exception when it is severe. Naturally it is better to

treat even a benign growth while it is small, though it does not lose its reaction to irradiation in the way that malignant growths do. In cases of nævus, the younger the child the more striking is the response to treatment.

The chief objection to irradiating *fibromyoma* in patients under 38 is that in rare instances cases of atrophy of the genitalia with kraurosis vulvæ have occurred in young people who have been treated in this way. Degenerating fibroids should not be treated, nor any case of fibromyoma in which there is a foul discharge. The radium tubes are inserted into the uterus and cervix (Chéron laid stress on the latter), and 150 to 200 mgrm. with a 2-mm. platinum filter applied for twenty-four hours is quite suitable. *X* rays will be used when the growth is very large or when radium is not available ; they may also be employed in addition to radium. The first period, after the treatment by either radium or *x* rays, is liable to be excessive, especially with *x* rays ; with radium it is exceptional. Treatment is applied from the outside, over the lower abdomen from the front, and over the sacrum behind. The direction of each cone of rays is so arranged that it takes in the uterus, the ovaries, and their appendages, the rays of each cone crossing. The complicated and finicking Freiburg technique, where a large number of small ports of entry are used, is quite unnecessary, and three or four ports of entry are sufficient. We find in these cases that if we give the whole treatment on one day, much irradiation sickness follows, but this can be avoided by spreading the treatment over from three to five days.

The best time to carry out the treatment is in the week preceding the menstrual period ; but this is not essential, and the treatment should be continued should the period commence during its course. Each series of treatments is repeated once a month, and the number required varies from three to six when full doses are used.

Angioma can be treated either by plaques of radium or by tubes arranged in the form of a plaque.

In all these tumours except the goitres full doses are used. In the goitres the patient is often not ill enough to disregard the effect of subsequent telangiectases, so that the doses must be kept down a little and the treatment not be prolonged over too long a time. In dangerous cases this is of course disregarded. Burying radium tubes in the thyroid avoids telangiectases.

I have attempted to show that the time has come when many surgeons must revise their opinions about some forms of malignant disease, and must abandon the hopeless attitude they so often adopt when the knife will no longer serve them. It is by no means the only weapon we possess with which to combat these conditions. In addition to the cases which are left to the radiologist entirely, there will be those in which prophylactic radiation is employed, and this will often save the surgeon from the eternal dread of recurrences. It will also, fortunately, reduce the number of recurrences sent to the radiologist for relief, which now hamper the work of his department.

In conclusion, I would urge most strongly that *inoperable* is no longer synonymous with *incurable.*

THE LYMPHATICS OF THE TONGUE: WITH PARTICULAR REFERENCE TO THE REMOVAL OF LYMPHATIC GLANDS IN CANCER OF THE TONGUE.

By J. KAY JAMIESON and J. F. DOBSON, Leeds.

The lymph glands of the neck which receive direct vessels from the tongue are: (1) *Submental glands*; (2) *Submaxillary glands*; (3) *Deep cervical glands.*

1. **The Submental Group.**—These glands lie in the triangle between the anterior bellies of the digastric muscles, usually midway between the jaw and the hyoid bone. They may be met with near the hyoid bone or under cover of the inner edge of the digastric. Usually they are three or four in number, though occasionally they are absent altogether. They receive vessels from the tip and frænum of the tongue.

2. **The Submaxillary Glands** lie between the submaxillary salivary gland and the lower border of the jaw. There are usually three: one at the anterior extremity of the salivary gland, and one in front of and one behind the facial artery as it reaches the bone. Other inconstant and small glands may be met with under or at the lower border of the salivary gland.

Our observations are in agreement with the description given by Stahr,[1] and we have not seen the profusion of glands described by some other writers.

3. **Deep Cervical Glands.**—The glands indicated by this term lie in loose tissue of the neck in general association with the great vessels. The majority are under the sternomastoid, but the obliquity of this muscle partly exposes the lower glands above the clavicle. This fact, together with a marked but irregular deficiency in the number of glands about the level of the thyroid cartilage, has led to a division into (*a*) upper deep cervical glands, and (*b*) lower deep cervical or supraclavicular glands.

The upper deep cervical glands have a wide irregular distribution from the level of the tip of the mastoid process to near the tendon of the omohyoid, and are mainly under cover of the sternomastoid. Some are in close contact with the front and outer side of the carotid sheath; several of these project at the posterior border of the sternomastoid, and have been called glandulæ concatenatæ; and some glands stray further backwards into the fatty tissue of the posterior triangle. Examined from in front, certain members are particularly conspicuous in specimens injected from the tongue, and merit special mention: these are a large gland and a variable number of smaller nodes lying in a triangle formed by the posterior belly of the digastric, common facial vein, and internal jugular vein. These may be called the jugulodigastric glands: the largest member, so named by Leaf, projects at the anterior border of the sternomastoid below the angle of the jaw, and is easily palpable in many living subjects.

The lower deep cervical glands lie in the lower part of the posterior triangle, and extend inwards under the lower part of the sternomastoid, in close relationship with the subclavian vessels, brachial plexus, and posterior belly of the omohyoid. The innermost members are under the sternomastoid in relation with the central tendon of the omohyoid; and one gland, conspicuous in our injected specimens, situated on or just above the omohyoid, frequently presents at the anterior border of the sternomastoid. It might well be regarded as a low member of the upper deep cervical glands, but, as any vessel which reaches this gland but fails to enter it must pass on to some gland of the lower deep group, we prefer to include it in this group. From its connection with all parts of the tongue we have to refer to it frequently, and suggest the name jugulo-omohyoid gland.

The superficial cervical glands which lie around the external jugular vein behind the angle of the jaw, and the glands about and below the parotid gland, were examined in every specimen, but no injection was ever traced to them from the tongue.

The Lymphatic Plexus of the Tongue.

The plexus in the mucous membrane is continuous over the whole surface, and also with the intramuscular plexus. Behind the circumvallate papillæ the plexus is coarse, and the collecting vessels run towards the hyoid bone. In front of these papillæ the

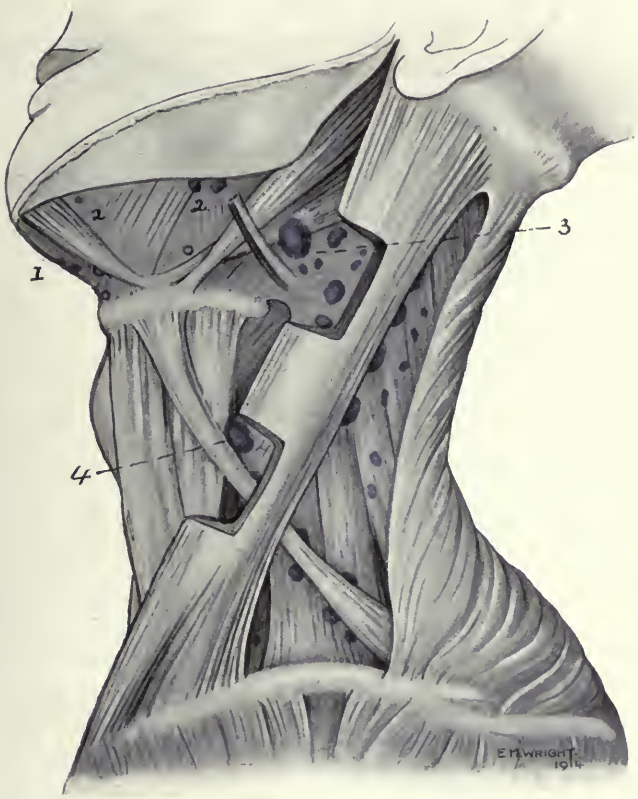

Fig. 38.—General view of glands of neck associated with the tongue. 1. Submental. 2. Submaxillary. 3. Jugulodigastric. 4. Jugulo-omohyoid.

plexus drains into two sets of vessels. One set (marginal vessels) descends from the edge of the tongue, draining the outer third of the upper surface, the margin, and the under surface; the other set (central vessels) drains the remaining part of the upper surface, most of the vessels descending in the middle line between the genioglossi; some few vessels descend in the muscular substance of the tongue, and may join either the marginal or the central vessels.

Course of the Collecting Vessels.

1. *Marginal Vessels.*—The vessels from the tip and region of the frænum descend under the mucous membrane. In glandular termination their distribution is very wide:—

a. Vessels perforate the origin of the mylohyoid muscle in close contact with the periosteum of the jaw ; one or more enter the submental glands, another descends over the hyoid bone, runs along the anterior belly of the omohyoid, and ends in the jugulo-omohyoid gland. It is very important to note that a vessel may arise in the plexus of one side, cross the middle line under the frænum, and end in glands of the opposite side. It is also interesting to note that the median-placed submental glands send their efferent vessels impartially to either side.

b. Some vessels turn outwards over the sublingual salivary gland, pierce the mylohyoid at its origin, and enter a submaxillary gland, usually the most anterior, but sometimes one or other of those associated with the facial artery.

c. Some vessels pass deeply under the sublingual gland and accompany the ranine vein, ending in the jugulodigastric glands, and perhaps also one of the deep cervical glands below these.

d. A vessel having the same course as (*c*) often turns down over or under the central tendon of the digastric to reach the jugulo-omohyoid gland, which accordingly may be injected from the region of the tip by two paths.

Some of the vessels of the lateral margin of the tongue pass outwards over the sublingual gland, pierce the mylohyoid muscle, and end in the submaxillary glands. Others run under the salivary gland with the lingual vessels and end in the jugulo-digastric gland or its neighbours, and in the jugulo-omohyoid gland. The vessels from the posterior part of the margin make their way through the pharyngeal wall with the dorsalis linguæ vessels or the glossopharyngeal nerve to the jugulodigastric gland, and to reach it may run on either side of the external carotid artery.

2. *Central Vessels.*—There is no clear line of demarcation between areas on the surface of the tongue draining into the marginal or into the central vessels. Whenever injection from a puncture at the edge of the tongue extends a third of the distance between the margin and the median raphe, some central vessels will be found injected. It may be that this occurs by means of the vessels descending through the muscular substance of the tongue.

The central vessels descend in the middle line between the geniohyoglossi muscles ; some turn outwards through the substance of the muscle, but the majority appear between the free borders of the muscles and diverge right and left. We must lay great stress on the fact that vessels from the plexus on one side of the middle line run to either side. The vessels run out between the genioglossus and geniohyoid, follow the lingual blood-vessels, and end in the deep cervical glands, notably the jugulodigastric and jugulo-omohyoid. Some pierce the mylohyoid and enter the submaxillary glands, even the most anterior. When the upper surface of the tongue is injected, the glands of both sides are generally found to contain the coloured mass. It is not usually the case that the fluid injection has crossed the middle line in the plexus ; vessels having their origin on one side of the tongue have entered glands on the other side of the neck.

3. *Dorsal Vessels.*—The vessels draining the area of the circumvallate papillæ and the surface behind them, run backwards. The vessels near the middle line may bifurcate and run to both sides. They turn outwards to join the marginal vessels, and all pierce through the pharyngeal wall, passing in front of or behind the external carotid artery to reach the jugulodigastric glands, the jugulo-omohyoid gland, and glands between these. A vessel may run down behind the hyoid bone, perforate the thyrohyoid membrane, and end in the jugulo-omohyoid gland. Probably owing to the absence of papillæ, the vessels as they run backwards on the tongue are very distinct, and it is not easy to convince oneself that they are not veins. We have, therefore, not considered any vessel to be a lymphatic unless it could be traced to a gland.

Many writers have mentioned minute glands which may be met with in the course of the lymphatic vessels, in the floor of the mouth or the deep surface of the mylohyoid. In a few cases only have we noted these minute glands.

Secondary Vessels.—The efferents of the submental glands run to the submaxillary and jugulo-omohyoid glands. Those of the submaxillary glands pass to the jugulo-

digastric, jugulo-omohyoid, and glands between. The efferents of the jugulodigastric gland and its neighbours pass to the glands on the great vessels, at and below its own level. The jugulo-omohyoid gland sends its efferents either to the jugular trunk or to the supraclavicular glands.*

THE REMOVAL OF GLANDS IN CANCER OF THE TONGUE.

Cancer of the tongue leads to invasion of the lymphatic glands at a very early stage. Many cases, apparently cured of the local growth by an early operation, succumb to glandular disease. A higher percentage of cures will be obtained, not merely by earlier diagnosis and operation, but also by a more complete removal of the lymphatic glands.

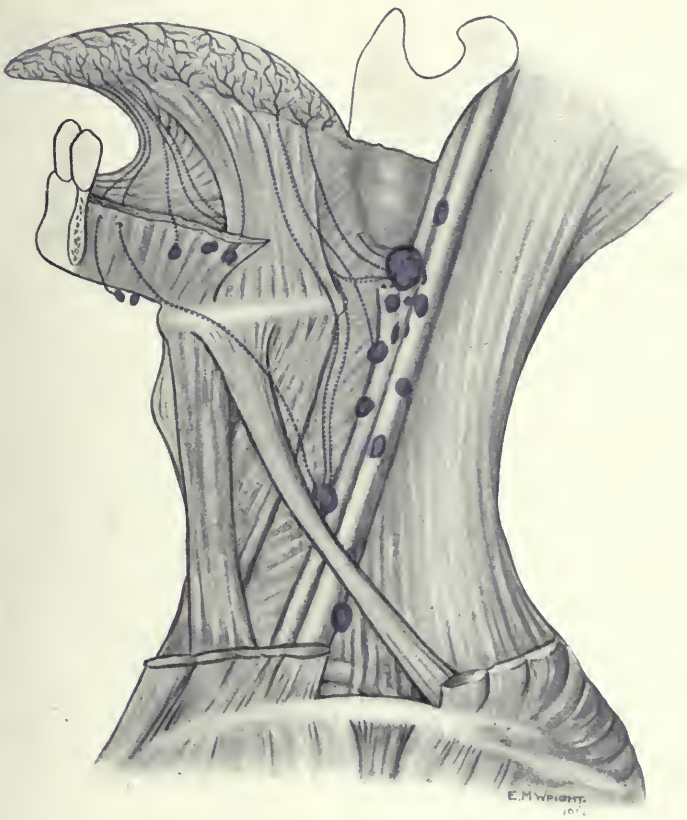

FIG. 39.—Course of vessels from tongue to the submental, submaxillary, and deep cervical glands.

We have seen that the following groups of glands receive vessels directly from the tongue: submental; submaxillary; upper deep cervical, including the jugulodigastric; lower deep cervical, with the jugulo-omohyoid.

Any or all of these gland-groups may contain diseased members in any given case of cancer of the tongue, however early. Success can only be expected if all the glands which are liable to invasion are removed in every case.

* The anatomical statements are based on the dissection of twenty-three specimens injected by Gerota's method. Some of the specimens were adult tongues taken from the post-mortem room; others were from stillborn full-term fœtuses.

The only really adequate method of removing the lymphatic glands in cases of cancer of the tongue is that described by Crile[2] as the *block-dissection of the neck.*

Dr. Crile describes two operations, one a partial and the other a complete block-dissection. The first, which he practises in cases where the lymphatic glands are not yet enlarged, consists in removing in one piece the upper deep cervical group, the submaxillary and submental glands, and the jugulo-omohyoid gland of the lower cervical group. To facilitate this a portion of the edge of the sternomastoid muscle is excised.

The complete block-dissection consists in removing in one mass the sternomastoid muscle, the internal and external jugular veins, a considerable area of the deep fascia of the neck, and all the groups of lymphatic glands : lower and upper deep cervical, submaxillary, and submental. The dissection is done from below upwards, the sternomastoid being divided just above the clavicle, the internal and external jugular veins doubly ligatured and divided, and all the structures to be removed stripped upwards from the arteries and deeper muscles. The internal jugular vein is ligatured above, close to the posterior belly of the digastric muscle. Crile prefers to minimize hæmorrhage by temporarily compressing the common carotid artery ; but this step is not at all necessary.

A great advantage of this operation is that, owing to the sacrifice of the sternomastoid muscle, all the gland-groups can be easily reached without difficult retraction and without the inconvenience of attempting to preserve the spinal accessory nerve. Excision of the internal jugular vein facilitates the removal of the upper deep cervical glands, particularly when these are enlarged. When the glands are not enlarged, it is possible to remove them satisfactorily and still preserve the internal jugular vein. This is an important point when the bilateral operation is indicated, as it is not always safe to excise both internal jugular veins.

The uppermost of the upper deep cervical glands can be more readily reached if a slice of the parotid gland is removed and if the posterior belly of the digastric is sacrificed. Part of the omohyoid muscle should also be excised while removing the lower deep cervical group.

The submaxillary salivary gland must be removed, as the lymphatic glands are closely applied to it ; it must also be remembered that one of these glands may lie on the outer surface of the mandible. The submental glands vary in position. To remove them satisfactorily it is wise to take the anterior belly of the digastric with the fascia, and to remember that one gland may lie at a low level on or below the hyoid bone.

With regard to the *partial block-dissection*, it is not known to us what is now Dr. Crile's practice, but it would not appear to be 'adequate', even in cases where there is as yet no obvious gland disease. The complete operation is to be preferred.

Bilateral Gland-operation.—Lymphatic vessels run to glands on both sides from the tip and frænum, from the dorsum, and from almost any point at the back of the tongue. Only from the lateral border are they confined to the same side of the neck.

The bilateral operation is therefore indicated in growths (1) of the tip and frænum, (2) of the dorsal surface, (3) of the back of the tongue, (4) of the lateral border which have spread towards the middle line.

When the process of permeation of the lymphatic plexuses around a lateral border growth has extended some distance over the dorsum, cancerous emboli, if detached, may pass into the central vessels running deeply in the substance of the tongue between the geniohyoglossi muscles. These vessels run to glands on both sides of the neck. When permeation of the lymphatic plexuses around such a growth is at all advanced, it is possible that a reversal of the normal direction of the lymphatic stream may occur. In such case the glands on the other side of the neck are easily involved.

Taking all the aforementioned facts into consideration, it is evident that a unilateral gland operation is adequate only in those cases where the growth is limited to the lateral border of the tongue, and has not extended forwards or backwards or on to the upper surface to any extent. We have had experience of cases where the patient has refused the bilateral operation, and in every instance disease has appeared in the glands of the opposite side.

The Removal of Lymphatic Vessels between the Tongue and the Glands.—It has been taught that an operation for cancer cannot be considered adequate unless the primary growth, with a sufficient margin of healthy tissue, the lymphatic glands, and the intervening lymphatic vessels, are removed in one piece. Attempts are made to operate on these lines in cases of cancer of the breast, colon, penis, and other organs, and of late years operations founded on this principle have been practised for cancer of the tongue.

Probably all surgeons will agree that, at the present time, the preliminary removal of the tongue, with a gland operation at a later date, is infinitely safer than any of those operations which are devised for removing the tongue with the lymphatic glands and the

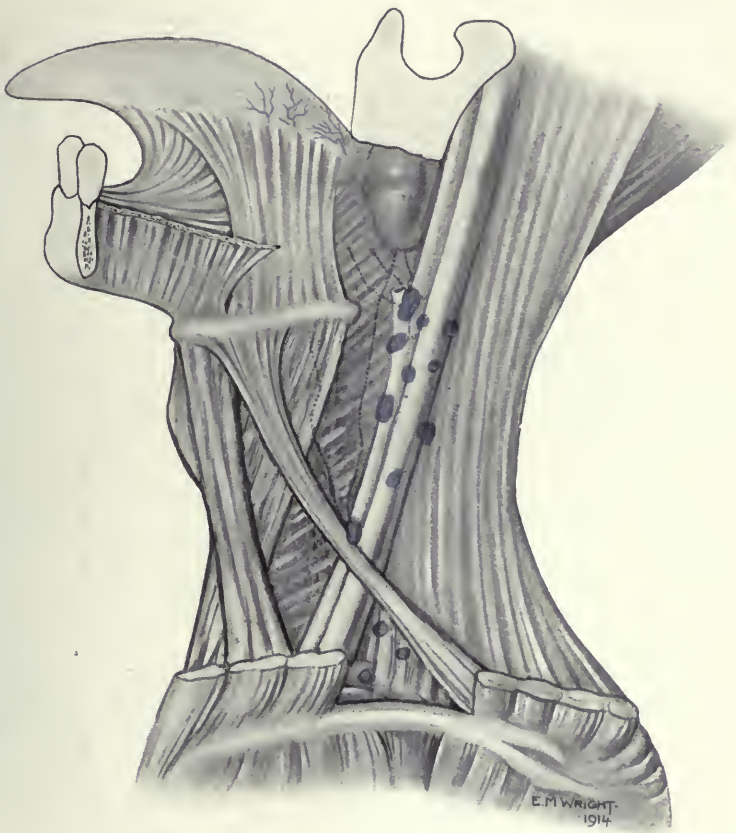

FIG. 40.—Distribution of vessels from the postcircumvallate area of the tongue to the deep cervical glands. Note vessels perforating pharyngeal wall below tonsil, some winding behind the carotid vessels.

intervening tissues in one mass. The argument used against the operation in two stages is that the lymphatic vessels, between the growth and the glands which are not removed, may contain cancer cells. The whole question depends on the method by which the lymphatic glands are invaded, by embolism, or by the gradual growth of columns of cancer cells along the vessels—permeation. If the glands are involved as a result of permeation of the large vessels, i.e., if columns of cancer cells grow along these vessels to the glands and then give rise to gland disease when, and not until, they reach the glands, then it follows that in every case in which disease can be demonstrated in a given gland there must be cancer cells in a lymphatic vessel or vessels running to it. This cannot be demonstrated. Further, if the glands are invaded as a result of permeation of the large

lymphatic vessels, no case with gland disease, however early, could be expected to be cured by such an operation as Butlin[3] commonly practised, viz., intrabuccal excision with subsequent gland dissection, for in all such cases permeated lymphatic vessels must have been left behind. Still, Butlin was able to say that "out of 70 cases in which the anterior triangle was completely cleared out, and a number of cases in which glands were simply dissected out because they were enlarged, I have very rarely removed the primary disease and the glands in one continuous mass. Yet 29 of these cases proved to be successful."

Sir George Lenthal Cheatle's work[4] on the spread of cancer of the tongue is of the greatest importance. He has shown that the deeper muscles of the tongue are much more widely affected than was generally thought. This invasion appears to be the result of permeation of the lymphatic plexuses of the muscles of the tongue. But he does not show

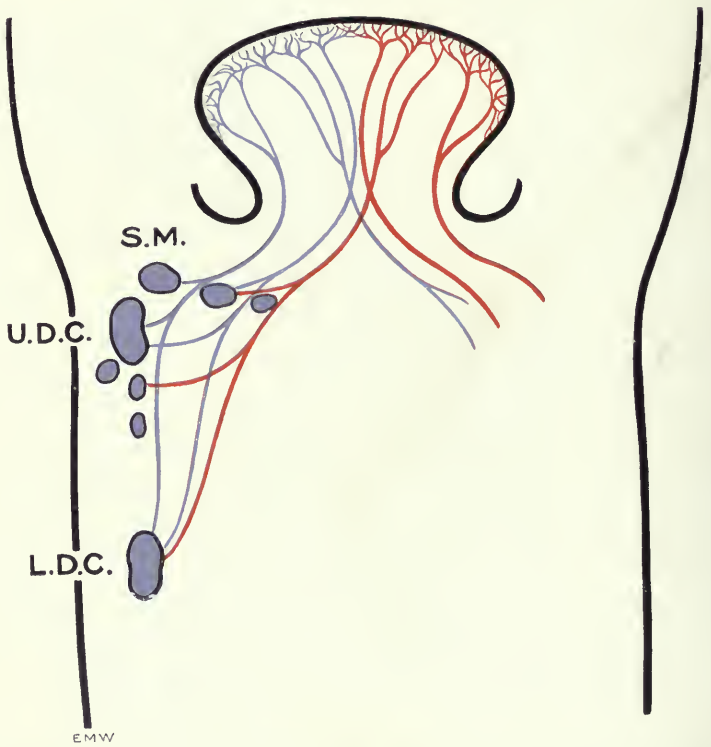

FIG. 11.—Diagram to show course of the central lymphatic vessels of the tongue to glands on both sides. S.M. Submaxillary glands. U.D.C. Upper deep cervical glands. L.D.C. Lower deep cervical glands.

that the larger vessels are permeated. It seems that, while the lymphatic plexuses and smaller vessels within the tongue are permeated, the large vessels running from the tongue to the glands are not, except perhaps very late in the course of the disease, and that gland invasion is the result of embolism. The removal of the large intervening lymphatic vessels does not appear to be necessary; but even if it were it is not practicable.

We need only recapitulate the course of the larger lymph-vessels running from the tongue to the glands. From the tip of the tongue and frænum they run, as we have said, close to the periosteum of the jaw and through the mylohyoid, and also above and below the hyoglossus muscle with the lingual vessels and hypoglossal nerve. From the lateral border they run over and under the sublingual gland with the blood-vessels. The central vessels on their way to the glands have a similar course. From the posterior part of

the margin, and from the back of the tongue, vessels pierce the pharyngeal wall and run on either side of the external carotid artery.

It is obvious that if it were necessary it is really impracticable to remove all the lymphatic vessels intervening between a growth of the tongue and the invaded glands. It is unlikely that the high recurrence-rate after operation for cancer of the tongue is due to leaving this intervening tissue. It is due, on the one hand, to incomplete removal of the primary growth—to leaving the deeper muscles of the tongue, which Lenthal Cheatle has shown to be extensively invaded—and on the other, to imperfect gland operations.

It is probable that in early growths an intrabuccal operation will suffice if care be taken to cut the tongue off close to the hyoid bone ; but in the later cases an extrabuccal operation is essential.

We may conclude by stating what methods of operation appear to be 'adequate' in cancer of the tongue, in view of the lymphatic distribution we have described.

In early growths of the lateral border of the tongue, a unilateral *complete block-dissection of the neck* with intrabuccal excision of half the tongue, at one sitting, is indicated. This operation is quite satisfactory and not unduly dangerous. If, however, the patient is not in good condition, the intrabuccal operation may be done first and the gland operation at a later date.

In quite early small growths of the tip and frænum, or on the dorsum of the tongue, a *unilateral block-dissection* with intrabuccal excision of the tongue at one sitting, followed by a block-dissection of the other side of the neck at a later date, is required. The internal jugular vein should be preserved during the second block-dissection.

In more advanced growths of the lateral border, tip and frænum, and dorsum, and in all growths at the back of the tongue, an extrabuccal operation (Syme, or some modification) is essential, as is also a *bilateral block-dissection of the neck*, preserving the internal jugular vein on one side. This is impossible at one sitting, highly dangerous even at two, and only to be done with any degree of safety at three sittings. It is difficult to induce patients to submit to a three-stage operation.

In cases where the growth has spread from the tongue to the floor of the mouth, jaw, or tonsil, nothing less than a *bilateral block-dissection* of the lymphatic glands will be 'adequate', whatever be the nature of the operation on the primary disease.

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ON THE TECHNIQUE OF RE-AMPUTATION.

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Though most of the men who suffered amputation in the War have now been fitted with good artificial limbs, quite a considerable number of pensioners are still to be seen who, for one reason or another, cannot be fitted with a limb, or will not wear the one they have. The object of this paper is to show which of these cases would be benefited by re-amputation, and to set forth the technique which, in the writer's experience, has appeared to give the greatest proportion of successes. Moreover, the time is not far off when artificial limbs will be standardized to some extent, as regards design, and it is therefore of great importance that some uniformity should be adopted, if possible, as regards the fashioning of amputation stumps.

The main desiderata in a stump are that it should be: (1) *Useful*; (2) *Of suitable length*; (3) *Of suitable form*; (4) *Painless*; (5) *Well covered*; and (6) *Well nourished*. Let us consider these points in detail.

It does not follow that the greatest length that can be retained in a limb is necessarily the most useful. For instance, in amputation through the leg, there is nothing to be gained by amputating through the lower third instead of at the junction of the middle and lower thirds; the extra length of bone does not confer any greater stability upon the wearer of an artificial limb, or any better movement of the joints, whilst it often gives rise to trouble through insufficient covering. Again, disarticulation through the elbow or the knee is not so good as amputation rather higher up, because it is impossible to make an artificial joint at the same level as its fellow, quite apart from the fact that the stump is bulbous and difficult to fit.

On the other hand, it is most important that a sufficient length of stump should be preserved to afford proper leverage and control of the joint above. With the limbs that are in common use to-day, it has been found that an arm stump must be 10 cm. long, a forearm stump 10 cm. long, and a thigh stump 12 to 14 cm. long, if a useful amount of flexion is to be retained at the joint above. If the limb is unusually bulky, so that the prosthetic appliance does not grip the bone as firmly as usual, these amounts must be increased somewhat. In certain cases, a very short stump below a joint is actually detrimental, and is better sacrificed. At the shoulder, for example, an inch or so of humerus is quite useless, and prevents the application of a decent-looking limb. The same remark applies to short lengths of the upper part of the femur. Again, many surgeons, though not all, consider that nothing is gained by preserving an inch or so of the upper end of the tibia, or the astragalus and ankle-joint; they argue that to have a joint that is practically uncontrollable at such a short distance from the end of a stump is a source of instability, and is therefore disadvantageous. With this view I, personally, concur.

The question of length is controlled to some extent, moreover, by the condition of the joints above. (This is a point that has often been overlooked, judging by what one sees at the Appeal Boards of the Ministry of Pensions.) For example, if a man has a perfectly stiff knee, he does not gain very much by having four inches of tibia preserved; he would be better off with an amputation higher up and a good modern limb with a controllable balanced knee-joint. As regards length, then, we must be guided, not by rule-of-thumb alone, but mainly by a common-sense consideration of the functional value of the part that we are thinking of preserving.

As regards *form*, one may make a generalization, and say that the best shape, from the point of view of the instrument-maker, is that of a gently-converging cone—after the shape of a medicine-bottle cork. Such a stump always fits snugly into the bucket, and

also affords a wide surface over which pressure and weight-bearing may be distributed; the limb can be made of neat shape, and provision is easily made for 'taking up the slack' if any wasting occurs. Furthermore, the grip is so good that end-bearing is never necessary, which is a great advantage if the end of the bone is unfortunately rather tender and yet it is very desirable that no more bone should be removed. (This condition may obtain, for example, when the length of stump is already nearing the functional minimum laid down above, and perhaps the other limb has been amputated at an even higher level.)

Pain in a stump may be due to a variety of physical causes, apart from pain of purely subjective origin, with which we are not now concerned. Pain due to the formation of fibroneuromata has long been recognized; it is generally of a toothache-like character, but is invariably associated, as far as my experience goes, with marked local tenderness at the site of the neuromata; pressure there gives rise to an intense darting pain, of a neuralgic kind, which is stated either to shoot up the limb, or else to travel to the periphery of the part that is lost. In other cases we meet with quite small areas, or even points, in the flaps, which are acutely tender; it is assumed that these are due to small nerve filaments being caught up in scar tissue, and apparently the supposition is correct, for the undercutting or excision of the scar relieves the pain for the time being. This, however, is a bad method of treatment, for the nerve fibres soon grow down again, and the pain recurs. In many stumps tenderness is due to inflammatory trouble in connection with the bone itself; there may be chronic periosteomyelitis going on there, which results simply in the characteristic deeply-seated boring kind of pain; or perhaps bone proliferation is taking place, and spikes of bone are forming, which jut out into the surrounding muscles and other tissues, and naturally cause pain there. In yet other cases the inflammation of the bone is rather more active in type, and a skiagram will show that a sequestrum is separating, or that there is a considerable thickening about the bone, in which, presumably, some septic matter is pent up.

Generally speaking, the bone in an amputation stump shows marked rarefaction and absorption under the *x* rays; but I have seen one or two cases in which the patients complained of nothing but an inveterate aching, and no cause could be discovered except marked thickening and sclerosis of the bone. Presumably these were cases in which the irritation set up by the sepsis was just enough to stimulate osteogenesis, but not enough to cause absorption or necrosis. Acting on the analogy of Brodie's abscess, I drilled the bone for two of these patients, using a $\frac{1}{8}$-inch drill, and making perhaps a dozen holes or more; this at once relieved the pain, which had been constant for over two years. Whether the effect will be lasting remains to be seen; presumably the drill-holes will eventually fill up with bone; but one supposes that as long as there is tension within the bone, exudation will take place, and this will keep the holes open, and also lower the vitality of any organisms that may be smouldering within. In other words, one is really treating the pain by draining the sclerosed bone into the soft parts around. The sepsis is of such a mild order that no harm ensues.

Lastly, there is a class of case in which the whole stump appears to be more or less tender. Everyone has seen these cases in abundance during the War, and even in the civil surgery of the days before the War they were not unheard of; yet no one seems to have described them separately, or tried to reason out their pathology, and the logical treatment that should ensue. In such cases sepsis has always been a prominent feature: that, no doubt, explains why they were more common in the early days of the War than towards its conclusion, and why they are less common in civil than in military surgery. Yet they are quite common amongst civil cases in which considerable suppuration has occurred, as, for example, after accidents and compound injuries.

The tissues of the stump, in these cases, are almost always of a more or less indurated, rubber-like consistence; they often feel tough and tense, and are more or less matted together, so that it is impossible to distinguish the skin, fat, and muscles by palpation, and to move them over one another; there is just one tough, resilient whole.

An analogous condition is to be seen in the ordinary stump that results after laceration of the fingers; very often the whole finger becomes tough and ill-nourished, and very

tender, so that the patient is unable for months afterwards to use it for any manual work. Sometimes there are individual tender spots, sometimes the whole thing is uniformly tender and useless. If one excises the tender spots in the skin, the result is invariably disappointing; but if an inch or more of the cutaneous nerve of the part is removed, the result is better, and the pain is relieved for some time; but eventually it recurs in many cases, and in a large proportion a small fibroneuroma forms upon the cut end, higher up. In fingers that show general tenderness, no operative treatment is of the slightest use; it only stirs up trouble and makes matters worse. The only hope is to amputate the finger through healthy tissues, or else to leave it alone until the pain disappears, which it generally does, in course of time.

A moment's reflection will show that these two types of case, the generally-tender finger and the generally-tender stump of a limb, have this much in common, that they are invariably the outcome of a septic lesion. They are never seen in cases which have run an aseptic course. The same holds good of fibroneuromata, in my experience; they are extremely rare in aseptic cases, whilst they are common where there has been prolonged suppuration. Having watched a number of cases of ordinary lacerated finger very carefully, and operated (more or less unsuccessfully) in some of them, I came to the conclusion, some years ago, that fibroneuromata were to be regarded in these cases as being essentially irritative and septic in origin. Apart from the etiological fact that they only occur in septic cases, there is some pathological evidence for this view, in that the nerves are always seen at operation to be swollen, red, and congested; under the microscope they show all the ordinary changes of chronic neuritis.

When the War came, a number of observers soon demonstrated that microscopical evidence of inflammation was to be found at a considerable distance from the track of the missile, in almost all cases; at a late date, in fact, the tissues are absolutely permeated with round cells and other inflammatory formations. Professor Marinesco, working with Edred Corner, demonstrated that foreign bodies or bacteria were to be found in fibroneuromata in almost all cases, and that not only the nerves themselves, but the surrounding tissues also, were densely infiltrated with inflammatory material. Still later, it was shown by Corner that the nerve filaments were by no means confined to the recognized anatomical nerve paths, but were often found to have wandered off along new paths of their own. Sometimes they followed the path of an adjacent blood-vessel; sometimes they tracked along a tendon or any other convenient structure; sometimes they wandered aimlessly through the tissues, not following any particular path. This supports what has already been noticed in the case of septic fingers; it was not the nerves only that caused the tenderness, or that were inflamed; it was the whole stump; and to deal with the nerves alone was disappointing, because numerous filaments would be left behind, that were irritated by a chronic inflammatory process going on in and around them. In other words, *the tenderness and pain in many amputation stumps (whether of limbs or of fingers) is caused by a generalized inflammatory condition of all the tissues of which it is composed, and not of the nerves or nerve-endings only.*

This has a most important bearing on treatment; indeed, it supplies the clue to the successful treatment of these cases. It is obvious that the inflammation will be most acute around the tissue that has been the most severely and persistently infected; as a rule this will be the bone, for though the soft parts may be the last to heal, yet it is in the bone that organisms are most liable to lie latent. In the soft parts, organisms are not liable to persist for long, except, perhaps, in masses of avascular scar-tissue. It may be laid down as an axiom that *no operation for the relief of pain or tenderness in an amputation stump will be wholly successful, if a zone of latent sepsis is entered in the process.*

Nor will success be attained if there is the least tension in the *coverings* of the stump. Many amputations were performed during the War in which the flaps were cut much too short. In compound fractures, and especially in those military fractures which are produced by high-velocity missiles, the ordinary civil rule (that the combined length of the flaps shall equal one and a half times the diameter of the limb at the level of bone-section) is altogether inapplicable. Very often there is considerable suppuration, and whilst this

is being overcome the flaps shrink and retract greatly. The muscles are damaged, if not actually devitalized, over a considerable distance from the initial wound, and during the healing process all this area becomes permeated with inflammatory products, much of which becomes altered into connective tissue, which slowly but inevitably contracts, like all young scar-tissue in every part of the body. Again, after severe injuries the muscles are thrown into a state of violent spasm, and are much more excitable than normal muscles; there is consequently an abnormal tendency to retraction of the flaps. It cannot be emphasized too strongly that the commonest mistake of inexperienced operators in cases of compound fracture is that of cutting their flaps much too short; they should always be capable of covering the bone without the slightest tension, and a moderate excess is not detrimental in any way. To turn back short flaps, with the idea that they can be brought down after the suppuration has been cured, is futile; they always retract and become so fibrosed that this is practically impossible. In thoroughly septic cases it is far better to amputate as low down as possible in the first instance by the flapless method, get rid of all infection, and then re-amputate later at a higher level through normal or comparatively normal tissues. By using the flapless method, the sepsis is reduced to the minimum, and is localized to the tissues immediately adjacent to the cut surface; consequently, the re-amputation always follows a course that is clinically aseptic, and the result is correspondingly good; the covering of the stump is ample, and there is no tenderness. If, on the other hand, the surgeon tries to fashion elaborate flaps at the outset, infection will often be prolonged and widespread; the tissues may become impregnated with it, and, when re-amputation becomes necessary, fresh inflammation is set up, sinuses may form, and even fresh necrosis of the bone may occur. Thus, in course of time, a third operation becomes necessary, with a correspondingly bad result, quite apart from the loss of time and money, the disappointment of the patient, and the pain to which he is subjected. I have seen cases in which, through failure to appreciate the importance of performing the final amputation through clean tissues, the operation has been repeated as many as five times. I am strongly of opinion that, whenever we decide that a patient must undergo re-amputation, we should design our operation, if possible, so that he ends with a stump that has all the characteristics of a good civil amputation that has run an aseptic course. The scar should be thin, linear, and non-adherent; there should be no thickenings in it at the site of former sinuses, and the coverings of the stump should be ample, supple, and not infiltrated with old inflammatory products.

When it was found that the flaps were of insufficient length, attempts were often made to drag them down by means of weights or of elastic traction. This is a perfectly futile proceeding. I have no wish to disparage the use of traction in preventing undue contraction in flaps that are of proper length; in view of what has been said already about the marked tendency to spasmodic shortening in these cases, this is clearly a very wise and necessary proceeding; but to attempt to convert short flaps into satisfactory ones by this means is useless. One may possibly succeed in dragging the flaps down to a certain degree, and then getting granulation tissue to grow over the remainder of the stump: perhaps skin-grafting will be employed for this purpose, or to expedite healing; but I have never seen a stump made in this way that could be called really satisfactory. When there is sufficient length of stump, it is far better to re-amputate higher up; when there is not, it is wiser to provide a thoroughly good and ample covering for the end of the bone by means of a pedicled flap from some other part of the body. For example, I had under my care a lad who had suffered amputation through the right forearm four inches below the tip of the olecranon: the movements of the elbow-joint and superior radio-ulnar joints were perfect, but he had a badly-covered stump, for the ends of the radius and ulna were almost protruding through a thin scar, which had been made by skin-grafting a scanty bed of granulation-tissue, after dragging down two very short flaps. He could not wear an artificial arm. If I had removed more bone, the power of controlling his elbow and his voluntary pronation and supination would have been lost. I therefore excised the unsatisfactory covering, and grafted a cup-like covering of skin and subcutaneous fat by means of a pedicled flap of tissue from the anterior abdominal wall. The result

was most satisfactory. The same technique can be applied to leg stumps from which no more bone can be spared: and here it is even more important to give a good covering than in the case of the arm; for in the arm, the artificial limb tends rather to fall away from the stump, whereas in the leg there is often some end-bearing, through the limb being thrust up against the stump. True, end-bearing can be avoided by making the stump of a tapering form; but it is just in cases of short stump that we require all the bearing we can get.

Let us now review the various factors that we have considered as bearing upon the technique of re-amputation. In the first place, we shall always have to consider whether any more tissue can be spared, having regard to the ultimate functional value of the limb; if it can, re-amputation must be considered; if it cannot, pedicled grafting may be advisable in those cases in which the disability consists entirely in faulty coverings. Next, we have seen that tenderness or pain in a stump is by no means always attributable to the nerves, or to neuromata, or to nerve-filaments incarcerated in the cutaneous scar; very often there are other structures involved as well, or the whole stump is tender on account of a low-grade inflammatory condition. To cut into such an inflamed zone, or even a zone of latent sepsis, is unjustifiable: such a proceeding often stirs up trouble, and never relieves it. It is clearly far better to try to deal radically with all the possible sources of pain in one comprehensive operation, and not to tinker with any one of them.

The logical outcome of all these considerations is that one should try to make a block-dissection of all the pathological tissues involved, and at the same time fashion a stump of appropriate shape and length. To be more precise, one should not dissect at all; dissection merely means opening up numerous new planes to possible infection, with consequent delay in healing, and spoiling of the result. We should aim, rather, at *block-excision* of the damaged tissues. Such a method is simplicity itself in actual practice. Instead of trying to unearth tissues that are more or less unrecognizable, and to make artificial separations between them, one divides the tissues *en masse*. Even the main arteries of the limb can be safely divided in a block-excision of this kind, for when some time has elapsed since the primary amputation, they are always so small that the loss of blood consequent upon division is quite unimportant.

DETAILS OF THE OPERATIVE TECHNIQUE.

The technique can now be discussed. Let us suppose that the case is an ordinary one of more or less pointed thigh stump, in which the bone is inclined to protrude, the cutaneous scar is rather thick and irregular, the muscles towards the end of the stump are stretched and fibrotic, and there have been several sinuses at some preceding time. Also, as likely as not, there will be some chronic osteitis about the end of the femur.

A tourniquet may or may not be used: the loss of blood is not considerable when it is not used, and its use involves two disadvantages: (1) It is uncomfortably near the site of operation, and restricts the movement of the soft parts by binding them tightly down; (2) It prevents one seeing at the time of operation which tissues are plentifully supplied with blood, and which consist of more or less bloodless scar-tissue. On the whole (though I prefer a tourniquet for most limb operations), it seems wiser generally to dispense with it in re-amputations.

The other leg being tied out of the way, the stump is held well up, and an incision made with an ordinary scalpel through the skin, as near as possible to the scar. It is useless to include scar in the flap; the incision must be through normal skin; if it is redundant, it can always be trimmed away later before sewing up. The incision is deepened through the fat and superficial fascia, the scalpel being held obliquely, so that it cuts in the direction of a point three or four inches above the end of the bone: the general idea of the operation is to excise a solid cone of stump, containing all the pathological tissues, and leaving the cut surface of the bone as the apex of the conical space left.

As soon as the deeper layer of the superficial fascia is severed, the skin will probably retract easily ; it is seldom that the natural line of cleavage at this level is lost. The skin is therefore pulled back all round the stump as forcibly as possible ; if this does not give good enough access to the stump, it must be slit longitudinally on the outer side of the thigh, and sutured accurately again afterwards ; this manœuvre always gives ample access, and does not lead to any added disability. (A scar on the inner side of the thigh is much more objectionable.) A strong-backed amputation-knife about five inches long is now taken, and a bold sweep made round the more superficial muscles, still preserving the wedge-like character of the excision ; then again, this time cutting the deeper muscles and the periosteum, right up to the calculated apex of the cone to be removed. The main vessels of the limb will be severed at this second cut, but the assistant is ready with a powerful Mayo-Oehsner artery forceps, and catches them up at once, before any blood is lost. All the soft parts are now held well out of the way, and the bone is divided cleanly by means of a Butcher's saw. As a rule, it is best to steady the stump at this stage by grasping it firmly with a large Ferguson's lion-forceps, or a small Lane's forceps. Spouting vessels are now caught up systematically with Mayo-Oehsner artery forceps, beginning with those in the upper part of the flap ; otherwise, these bleed on to the vessels below, and obscure the view. The main vessels are tied with stout catgut ; some prefer to tie them with two ligatures, placed about half an inch apart, while others like a stay-knot. In the thigh, it is perhaps well to tie the artery and vein separately, but in all other situations I have always found that the vessels were so small and atrophied that there was no reason for not tying them both with one ligature.

The main nerves are now sought and pulled down ; each one is then carefully injected with absolute alcohol or with pure methylated spirit ; 2 c.c. are used for the sciatic, and 1 c.c. for all others. Many methods of dealing with the nerve stumps in an amputation have been described, but I have not had a single case of pain from neuroma since I adopted this simple expedient six years ago. The only precaution necessary is the very simple one of making sure that the whole thickness of the nerve is permeated with the alcohol ; to do this, I plunge the hypodermic needle into the very centre of the nerve, right up to the shoulder, and inject about half the total quantity ; then I withdraw it a little, and thrust it forward in some other direction, inject a little, and repeat the process. If this is properly carried out, the whole nerve immediately becomes swollen, white, and opaque. As the anatomical result the nerve is 'fixed', and such a dense coagulum forms at the end of it that no nerve fibres can penetrate it ; but I have never had a failure to relieve pain by this method, and therefore have never had an opportunity of cutting down on a nerve afterwards and examining it. The pain caused by this proceeding is not as great as one might expect, and it is easily controlled by morphine ; it never lasts more than two days, at the outside, and the excellence of the results quite justifies the employment of the method. At one time I used first of all to block the nerve higher up, by a preliminary injection of novocain or urea-quinine-hydrochloride ; but later on I preferred to get my alcohol in as high as I could, and then shorten the main trunk below as much as possible. The arteries that have been crushed will have ceased to give trouble by this time, and the artery forceps can be taken off ; in all probability no ligatures whatever will be required, which is an advantage when working in tissues of doubtful sterility ; but if any are necessary, they will, of course, be of catgut.

No special trouble is taken as regards the periosteum ; it is simply cut off flush with the bone, and left ; no disadvantage has been seen to accrue.

If the operation has been well performed, the muscles will fall together snugly over the end of the stump without tension, and no sutures need be passed through them ; if, however, they do not set nicely, and are inclined to expose the end of the bone, it may be well to draw them loosely together with one or two interrupted sutures of catgut, which should pass through the deep fascia ensheathing the muscles as well as through the muscles themselves. Lastly, the skin, fascia, and fat are adjusted edge to edge, and any gross excess of skin is trimmed away ; any pieces that seem at all indurated or puckered are also excised, the object being to secure everywhere a thin, mobile, linear scar, with

primary union. Any part, moreover, that is tied down and cannot be spared is cautiously mobilized by undercutting. A few mattress tension-stitches of the strongest black fishing-gut are now passed through the whole thickness of the flaps, and through the superficial part only of the muscles as well; these serve to prevent retraction of the muscles, to prevent hæmatoma and dead-space inside the stump, and to take all tension off the coaptation stitches in the skin. The skin itself is sewn accurately with fine salmon-gut or well-boiled thread, and then a piece of tube about three inches long, and as thick as a lead pencil, is inserted into the space beneath the skin, through a hole at the outer angle of the wound. It is secured in place by a stitch through it, and a loose one is passed alongside it, and left long, so that it may be subsequently tied and the space healed rapidly.

Much the best dressing consists in layer after layer of plain sterile gauze bandage, applied in roller fashion from above downwards whilst an assistant pulls the soft parts of the stump strongly downwards; applied in this way, the gauze exerts firm pressure upon the stump, moulding it into good form, arresting oozing, and preventing retraction of the flaps. For a thigh stump, about three six-yard rolls of gauze should be applied, followed by a thick layer of sterile cotton-wool roll, then a sterile bandage, more wool-roll, and a second bandage; the last may be a cap or a many-tail bandage, if desired. It will be found that a dressing like this will invariably prevent oozing and actual hæmorrhage, so that hæmatoma and all its complications will be absent, and the wound will heal readily, in spite of the large and vascular area of tissue that has been exposed. After forty-eight hours the dressings are removed for the first time, and the tube is withdrawn; everything is replaced with the least possible disturbance of the coherent skin-edges, and the loose suture alongside the tube is tied. After four days the tension-stitches are taken out; if they are left longer, they may impair the vitality of the skin included within the mattress, and it may slough to some slight extent; apart from this, they are no longer necessary. At the end of ten or twelve days all the skin-stitches are removed, and the wound will be firmly healed. It is well, however, for the patient to wear a domette or crêpe bandage round his stump for some time, simply for the purpose of keeping it in good shape.

After-treatment is practically nil; it consists simply in keeping the skin-scar mobile over the deeper tissues from the very first. It will eventually become displaced from the end of the stump, and will give rise to no trouble.

CONCLUSIONS.

1. The technique of re-amputation should be standardized.

2. The form of the stump must be determined partly by the kind of artificial limb that is afterwards to be fitted, and partly by consideration of the functional utility of the limb as a whole.

3. The tenderness is the outcome of chronic inflammation in the stump; this not only gives rise to osteitis and fibroneuroma, but also to pain in all the remaining tissues of the stump.

4. To secure a good result after a re-amputation, it is essential that the wound should follow practically an aseptic course, and the only way to ensure this is altogether to avoid cutting into a zone of sepsis or latent sepsis.

5. The best and easiest method consists in the excision of a conical piece of the end of the stump *en bloc*, without any dissection whatsoever. The cut passes through tissues which are practically normal, and heals by primary intention.

CLINICAL AND PATHOLOGICAL ILLUSTRATIONS OF DIVERTICULITIS.

At a recent meeting of the Surgical Section of the Royal Society of Medicine (Jan. 7, 1920) a number of radiograms and specimens of diverticulitis were exhibited. Through the kindness of the secretaries of the section, Mr. Sampson Handley and Sir C. Gordon Watson, we are enabled to reproduce illustrations of most of the cases described at that meeting.

For the purposes of description the cases may be divided into four categories, viz. :— (1) *Those in which symptoms were absent or slight*; (2) *Cases of stenosis of the intestine*; (3) *Cases of perforation*; (4) *Vesicocolic fistula.*

1. CASES WITHOUT SYMPTOMS.

Dr. E. I. Spriggs referred to the work on diverticulitis by Drs. Telling and Gruner[1] in 1917, D. Roberts[2] in 1918, and J. W. Keefe[3] in 1917, and said that the experience gained

Fig. 42.—*Case* 1. Male, 57. Multiple diverticula in the descending colon. One (not in profile) was seen in the transverse colon.

Fig. 43.—*Case* 1 (the same patient as in *Fig.* 42). Posterior view of descending colon. The lumen of the bowel is empty, but opaque material remains in the diverticula. The number seen is greater than in *Fig.* 42, because some show now which were not in profile when the bowel contained opaque material.

at Duff House supported the view that multiple diverticula could be recognized easily in *x*-ray photographs of the colon, but such cases had not been found to be common. In

the *x*-ray examination of over a thousand alimentary canals, diverticula of the large intestine had been seen six times. He had excluded between two and three hundred early cases from these figures, as they had not learned at that time the importance of taking photographs freely. The proportion of cases showing diverticula was, doubtless, understated by these figures, because in some cases the descending colon and sigmoid might not be completely filled at the times of examination; and if there were no bowel symptoms the opaque meal would not be repeated, nor would an opaque enema be given. Every effort was made, however, as a matter of routine, to see the descending colon and sigmoid when filled; and as the patient was in the same building as the *x*-ray room this could usually be done.

With good plates, when the little pouches were multiple and had reached the size of a small currant, they were easily seen. Diverticula in the early stages of their formation, or diverticula which were few in number and were filled with fæces or did not come into profile, might be missed; but if there were many of them, as there generally were, it was unlikely that none would fill with barium or show on the plate. As soon as they began to retain material longer than the bowel, that is to say, as soon as they were likely to be

FIG. 44.—*Case* 2. Male, 67. Thirty-six hours after opaque meal. One large and some smaller diverticula in the iliac and pelvic colon.

FIG. 45.—*Case* 3. Male, 71. Thirty-six hours after opaque meal. Diverticula in all parts of the colon. There was also one of the terminal ileum.

predisposed to inflammation, if at all numerous, they were obvious; for the chain of opaque dots lying along the course of the empty bowel was characteristic. All of their cases showed retention of barium in the diverticula. The accompanying illustrations (*Figs.* 42–47) are from plates by Mr. Marxer. These six cases of unsuspected diverticula of the colon were all males, of ages varying from 53 to 71. One showed a single diverticulum on the plate; in the other five the diverticula were multiple, and in three numerous. Two of them also showed one diverticulum in the terminal part of the ileum. In another there was a large single diverticulum, probably of a different nature, in the third part of the duodenum.

The divertieula of the colon are thought to be simple extrusions of the bowel wall at weak places. It is to be noted that they occur in those parts of the small and large intestine where the contraction of the muscle in the wall of the bowel may be supposed to

be especially vigorous, with a corresponding increase of pressure in the lumen, namely, in the last few inches of the ileum and the latter part of the colon. One of the patients had suffered from severe constipation, four gave a history of moderate or intermittent constipation, and one had never been constipated. In four of the six there was no *x*-ray evidence of delay in the bowel. In two there was such evidence, the opaque material not having passed through the colon in seventy-two hours. (The rate of passage of the buttermilk meal was quicker than that of some other opaque meals. With buttermilk forty-eight to seventy-two hours was regarded as a normal time.) In one case there was general hypertonus of the large bowel, and in another hypertonus of the pelvic loop.

FIG. 46.—*Case* 4. Male, 53. Sixty hours after opaque meal. A diverticulum in the transverse colon, and many in the descending colon.

FIG. 47.—*Case* 6. Male, 67. Ninety-six hours after opaque meal. Multiple diverticula containing material after the lumen of the bowel is empty.

The series was small, Dr. Spriggs said, but he brought it forward, firstly, to show how well diverticula could be recognized by the *x* rays ; secondly, because it was an early series. Not one of these patients had any symptoms clearly attributable to the diverticula which were seen. Of course, in view of the risks they run, their medical advisers would be kept in touch with. In all, the diverticulum-bearing area of the bowel was freely movable. The cases included two of chronic appendicitis (one of them with arteriosclerosis), two of duodenal ulcer, one of gastric hypo-acidity, and one of neurasthenia following a chronic infection. The last-mentioned patient had not been heard of recently. The other five recovered, and four of them were following active occupations.

Mr. L. E. C. Norbury showed a portion of a colon from which project numerous small sacculi of the mucous membrane extruded between the fibres of the muscular coat. Many contain pellets of hardened fæces. The specimen (*Fig.* 48) was from a woman, age 69, who died of cancer of the stomach, liver, peritoneum, and pleura. No stricture was detected, nor any other disease whatever of the large intestine.

Fig. 48.—Portion of colon with many small sacculi extruded between the fibres of the muscular coat. From a woman, age 69. (*No.* 1628, *St. Thomas's Hospital Museum.*)

A microscopical examination was made of one of the minute sacculi, the mouth of which is not more than 1 mm. in diameter. The sections were made so as to include the mouth, and although the mouth was so minute, on dissecting away the fat from the exterior, the sac was found to project slightly beyond the general level of the muscular wall. The wall of the sac consists of mucosa, furnished with a continuous muscularis mucosæ immediately beneath the crypts, and prolonged from that of the intestinal wall through the neck of the protrusion. The proper muscular coat of the bowel ceases immediately beyond the narrow neck of the sacculus.

2. CASES OF STENOSIS.

Mr. Hernaman-Johnson.—*Figs.* 49 and 50 illustrate a case of diverticulitis in a woman, age 60. Examination by an opaque meal and enema established the diagnosis of diverticulitis where cancer of the lower bowel had been suspected previously.

Twenty years ago the patient had had piles removed. Since then she has suffered a good deal from time to time, with discomfort in the lower part of the abdomen, and constipation alternating with diarrhœa. Until six months ago, however, the trouble did not prevent her from leading a very active life. Then she began to suffer from what she described as 'throbbing in the bladder', with increasing frequency of micturition. Also, 'windy spasms' in the lower bowel began to trouble her seriously. Finally she had an attack of partial obstruction, which passed off, after castor oil, with a blood-stained and very foul-smelling stool.

After the obstructive attack, clinical examination suggested the presence of a mass in the sigmoid region; but, owing to the obesity of the patient, the surgeon could not be sure of this. Cancer was suspected.

By means of an *x*-ray examination after an opaque meal the whole alimentary tract showed spasticity to a marked degree; but nothing definite was brought to light until the meal reached the descending colon after forty-eight hours. In the iliac colon and sigmoid were now noticed two or three small round patches of barium food, which were suggestive, but not conclusive proof, of diverticulitis (*Fig.* 49). When the meal was finally evacuated on the fifth day, the evidence was still insufficient for a final decision.

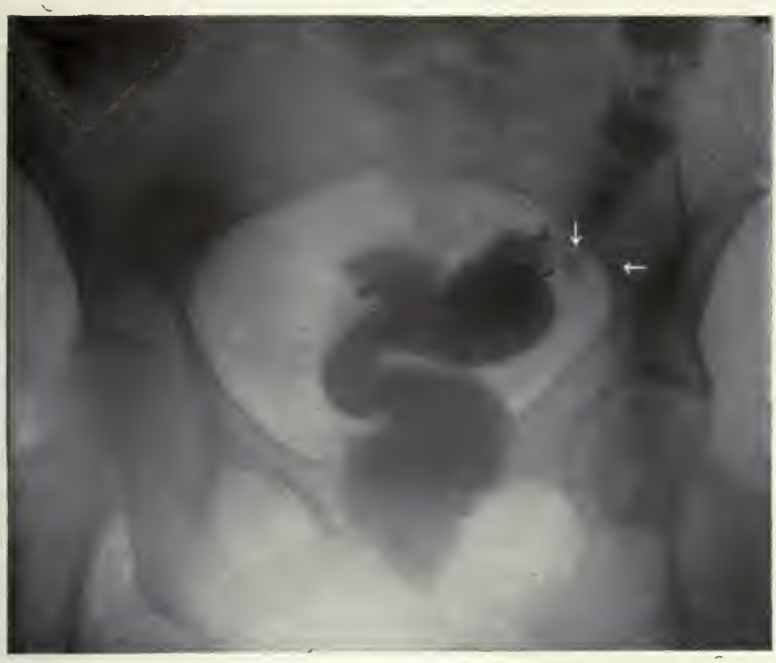

FIG. 49.—Opaque enema *in situ*. Shows diverticula, but no better than with the meal.

FIG. 50.—The same patient as in *Fig.* 49. After evacuation of enema. Numerous diverticula are shown. (This plate was much under-exposed, but fortunately its diagnostic value is not lessened.)

On the following day, after thorough cleansing by oil enema, a barium injection was introduced with considerable difficulty; this was due to narrowing of the sigmoid. Patches were seen similar to those observed after the meal, but it was not until after the evacuation of the barium enema that the diagnosis became really clear. The residues characteristic of a diverticulitis are well shown in *Fig.* 50, although the plate itself is not a technical success, being under-exposed. The opaque meal was evacuated in stiff masses, with considerable difficulty; on the other hand, the barium enema was a fluid introduced under pressure. These facts no doubt account for the better demonstration of the saccules in the latter case. Both methods are often called for.

At the operation, extensive diverticulitis, with much surrounding inflammation—peridiverticulitis—was found, and the sigmoid was narrowed by adhesive bands. There was no malignancy.

On the other hand, it should be noted that the *x*-ray examination cannot exclude cancer engrafted upon a pre-existing diverticulitis.

Mr. Lockhart-Mummery.—A case of hyperplastic diverticulitis.

The patient was a woman, age 57, with a six months' history of chronic obstruction and frequent small stools 'per rectum'. There was pain in the abdomen, and flatu-

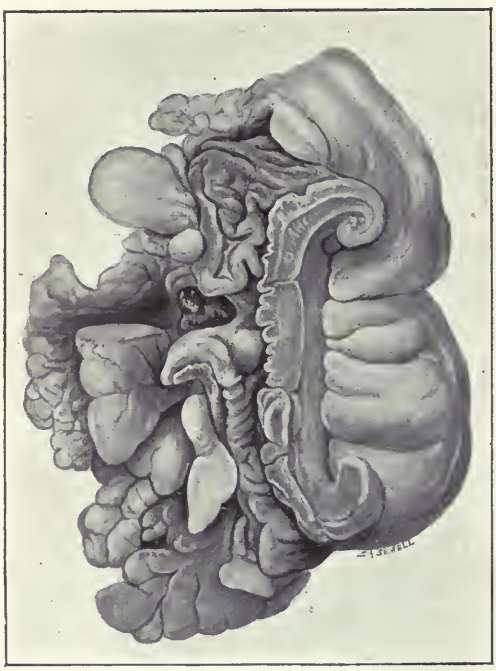

Fig. 51.—Hyperplastic diverticulitis, resulting from inflammation round a large single diverticulum containing a concretion, and producing stenosis and obstruction.

Fig. 52.—Diverticulitis of the pelvic colon. Showing diverticula of unusual size. The necks of the sacs show less constriction than usual.

lence, with a history of chronic alcoholism. At the operation a tight constriction in the centre of the sigmoid flexure was found and resected, with end-to-end anastomosis. The patient died from bronchopneumonia sixteen days later.

The specimen (*Fig.* 51) was thought to be cancer; but on laying it open was seen to consist of a stricture caused by fibrous contraction around a *large single diverticulum* which contained a stercoral stone.

Dr. G. de Bec Turtle showed a case in which the patient, a lady, age 69, had been complaining of increasing constipation for the past twelve months. An examination per rectum revealed a mass high up in the pelvis, which was thought to be probably malignant disease of the bowel. As it appeared to be movable, an operation was decided upon, and a preliminary colostomy was performed by Mr. Edmunds. Some three weeks later the tumour and lower bowel were removed through an extensive incision of the posterior vaginal wall.

The patient is making a slow recovery, and it is proposed to close the colostomy wound in the near future.

The specimen (*Fig.* 52) illustrates well the excess of subperitoneal fat. There is little evidence of hyperplasia or stenosis.

Mr. W. McAdam Eccles exhibited part of a pelvic colon which has been longitudinally divided to show numerous diverticula, with marked narrowing of the lumen due to fibrous thickening of its wall (*Fig.* 12). The mucous membrane shows chronic thickening and

Fig. 53.—Part of a pelvic colon with many diverticula, divided longitudinally.

pouching, with a number of minute lateral diverticula. At the upper extremity of the specimen is a larger diverticulum with narrow neck and bulbous extremity, which seems to pass into an appendix epiploica. The outer coats of the intestine are of pale-greyish colour, greatly thickened, tough, and fibrous. Strands of fibrous tissue are prominent in the surrounding subperitoneal fat.

Microscopic examination shows no evidence of malignancy, but an extreme degree of chronic inflammatory change, with fibrous thickening of the gut. The diverticula are lined by normal mucous membrane. The specimen was removed on Nov. 11, 1913, from a somewhat stout gentleman, age 74, who for more than a year had been troubled with obstinate constipation and flatulence. The motions never contained blood, but were

always much flattened in shape. A movable elongated tumour, thought to be a carcinoma, was felt in the left iliac fossa. The mass was excised, and end-to-end anastomosis was performed. No enlarged glands were present. Recovery was rapid and complete.

The free surface of the section of the tumour is not bounded by a definite epithelium, possibly owing to the fact that the particular section may be somewhat oblique.

The outermost zone consists of young fibroblasts or fibrous tissue. Deep to this is a layer of longitudinal muscle surrounded by circular muscle fibres. The core of the tumour consists of a loose connective tissue containing numerous blood-vessels and much fibrous tissue.

Sir C. Gordon Watson.—This specimen of hyperplastic diverticulitis exhibits part of a pelvic colon, laid open to show narrowing and inflammation associated with the presence of numerous lateral diverticula (*Fig.* 54). The surrounding peritoneal tissues are loaded

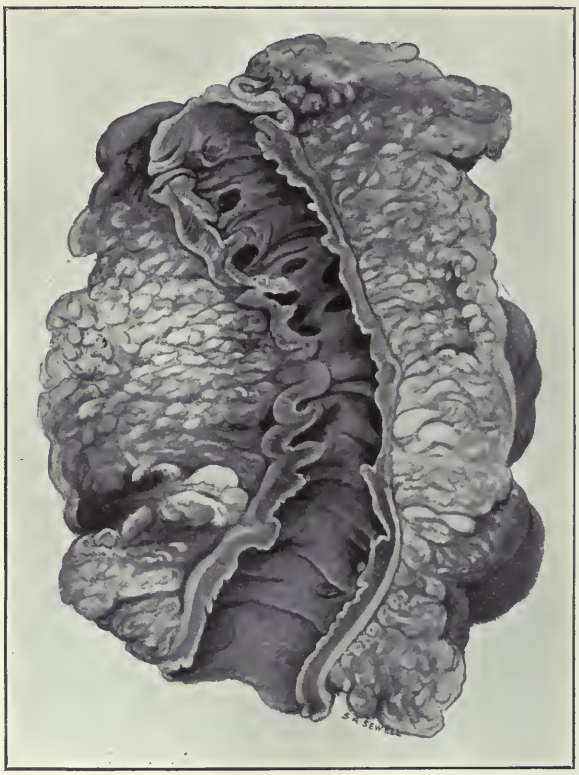

Fig. 54.—Part of pelvic colon, showing hyperplastic diverticulitis.

with fat, and are congested and swollen owing to the nature of the operation described below. The walls of the gut present a pale glistening appearance due to fibrous thickening. The mucous membrane is intricately folded and pouched so as to give rise to pockets and side channels, many of which still contain fæces. Some of these diverticula pass into the appendices epiploicæ, but this is obscured by the swelling of the peritoneal tissues. The lumen of the intestine is considerably narrowed.

The specimen was from a man, age 44, who had had an attack of jaundice twenty years previously. For fifteen years he had suffered from dyspepsia, and had experienced difficulty in complete evacuation of the bowels. Action of the bowels became increasingly

capricious, and three years before the operation blood and mucus were passed with the stools. A tender sausage-shaped swelling could be felt in the left iliac fossa. The abdomen was opened, and the diseased bowel, about six inches in length, was brought to the surface, and there fixed. Eight days later (June, 1914) it was excised and a temporary colostomy established. A year afterwards, in 1915, the colostomy was closed by Mr. Lockhart-Mummery. Two years afterwards (1917) there were recurrent symptoms of

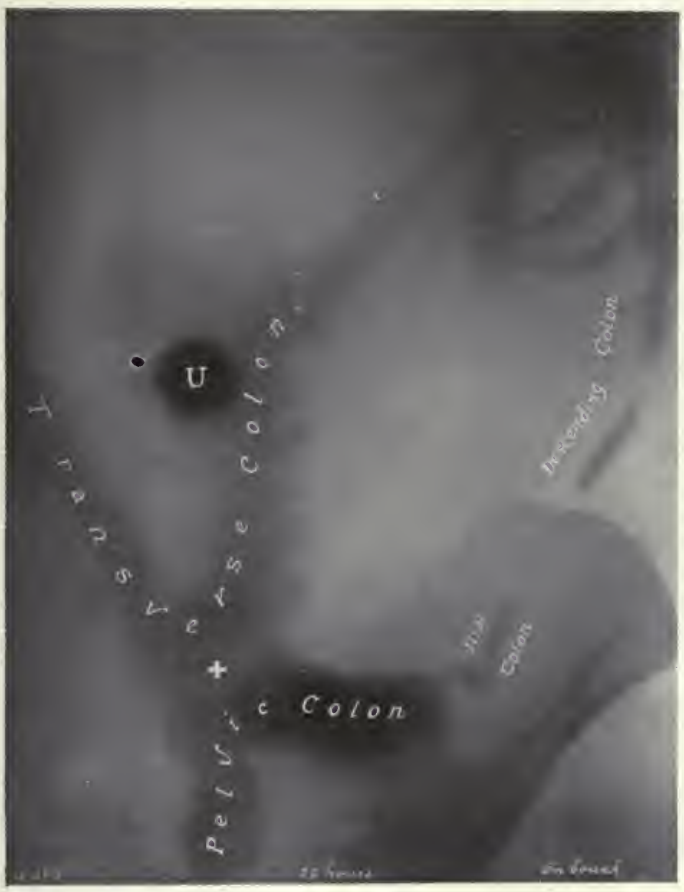

FIG. 55.—To illustrate ileosigmoidostomy after resection of pelvic loop and colostomy and subsequent closure of colostomy.

partial obstruction (diverticulitis above anastomosis). The transverse was now anastomosed to the pelvic colon at the junction with the rectum, and the radiograph (*Fig.* 55), taken a year later, in 1918, shows the anastomosis in function.

3. CASES OF PERFORATION.

Mr. CYRIL A. R. NITCH.—Perforating diverticulitis of the pelvic colon.

The patient, a female, age 49, had suffered from constipation for many years. At the beginning of November, 1919, she had an attack of acute colicky pain in the lower part of the abdomen, accompanied by constipation and tenesmus. A fortnight later she had another similar attack, with a slight rise of temperature, and passed some blood and

mucus. When examined bimanually under an anæsthetic, an oval mobile tumour was felt just below the brim of the pelvis on the left side. Sigmoidoscopic examination revealed nothing abnormal in the bowel below the tumour.

At the operation, Nov. 19, a hard, somewhat nodular tumour was found in the middle of the pelvic colon; it ended abruptly, and the bowel immediately above and below looked and felt normal. The adjacent mesentery was thickened, and contained a few enlarged glands. There were no adhesions. The remaining portion of the large bowel, the liver, etc., were examined and found normal.

As the tumour was thought to be a carcinoma, it was resected, and the continuity of the bowel restored by axial anastomosis. The patient made an uneventful recovery. On examining the portion of bowel removed, its lumen was found to be almost occluded by apposition of its walls, due to inflammatory thickening of the submucous coat and hypertrophy of the muscle. An abscess cavity, containing two ounces of odorous pus, was found in the attached mesentery.

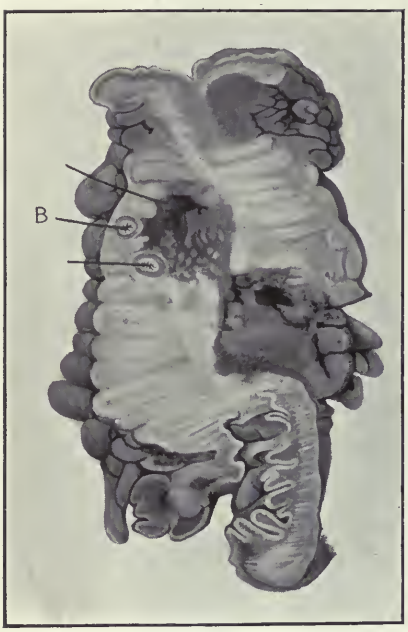

FIG. 56.—Section of pelvic colon showing perforating diverticulitis.

Professor S. G. Shattock has kindly supplied the subjoined description of the mounted specimen (*Fig.* 56):—

Portion of a pelvic colon, which was excised for the results of perforating diverticulitis. As shown at the back of the specimen, it is much contracted, the folds of the mucosa being mostly transverse; from the interior three black bristles have been passed; these emerge from the divided surface of the front of the preparation.

The two lower bristles lie in the lumina of two intestinal diverticula, the cross sections of which are readily discernible on close inspection, whilst the third, and longest, opens into an irregular cavity of necrotic and suppurating pericolic fat, in connection with a diverticulum which has perforated. The suppurating cavity extends across the mid-line to the other side of the bowel. The plane of section, which runs parallel with the gut, shows that the circular muscular coat has undergone a marked hypertrophy; the amount of this is best recognizable at the lower end, where the section has opened the lumen, the much greater thickness of the muscle higher up being due to the coat having been divided on the flat.

Microscopic examination of a section taken at the point B (*Fig.* 56) shows that the fat around the necrotic area is thickly infiltrated with polymorphs, and is hyperæmic, and that the mucosa lining the intestinal diverticula has a perfectly normal structure.

Mr. LIONEL E. C. NORBURY.—Perforating diverticulitis of the iliac colon.

Mrs. R., age 43. History of constipation for fifteen years, with an attack of diarrhœa eleven years ago, lasting for one month. Severe griping pains for the past six months. The right ovary had been removed for tuberculous disease three years previously.

On examination, a swelling was palpable in the left iliac region. On opening the abdomen, an adherent mass was found in connection with the iliac colon, closely simulating a carcinomatous growth. After removing the affected portion of the intestine, some five or six inches in length, the ends were closed and a lateral anastomosis was made. The result was successful.

Upon examination of the specimen (*Fig.* 57) the gut was found much contracted. The walls of the bowel showed hypertrophy and fatty tissue in abundance. On the lower right-hand side of the right-hand half there was an irregular cavity in the fat communicating with the lumen of the gut, due to 'perforating diverticulitis'. In the recent state the cavity contained pus, and pellets of inspissated fæcal matter. Microscopical examination showed all the signs of acute and chronic inflammation. There was no evidence of malignant disease.

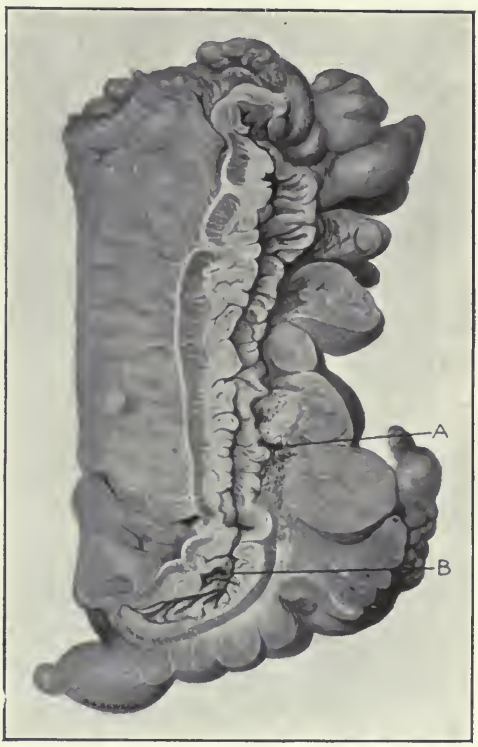

FIG. 57.—Portion of iliac colon, showing perforating diverticulitis. A. Perforated diverticulum: ragged abscess cavity. B. Contracted lumen of bowel.

Mr. EDMUNDS.—Two cases of acute diverticulitis of appendix. The specimen A (*Fig.* 58) is from a young woman, who presented the symptoms of acute appendicitis. A row of diverticula can be seen along the mesenteric border.

B is a specimen taken from a middle-aged man, who was admitted with symptoms of acute appendicitis. At the operation the appendix was found studded with diverticula, one of which had perforated.

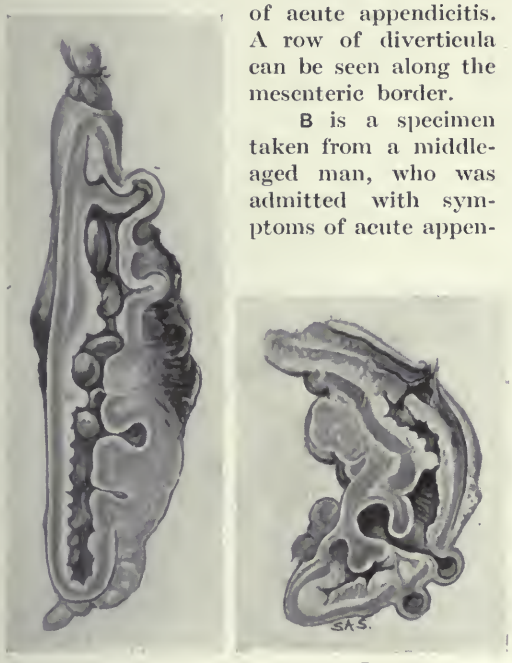

FIG. 58.—Acute diverticulitis of the appendix. A. Non-perforating specimen from a young woman. B. Perforating specimen from a middle-aged man.

4. CASE OF VESICOCOLIC FISTULA.

The following specimen of a vesicocolic fistula secondary to diverticulitis of the pelvic colon (*Fig.* 59) was not shown at the meeting:—

No. 945, Guy's Hospital Museum. A portion of the sigmoid flexure of a colon with the posterior wall of the bladder, to which it is firmly adherent. There is a fistulous communication, indicated by a rod, between the colon and the bladder. Neither viscus shows any sign of ulceration.

Hans K., age 65, was admitted under Mr. Bryant for the passage of wind and fæces by the urethra. Wind was passed twelve years previously, but no solid fæces until six weeks before admission. He had been in the tropics, but had never had symptoms of dysentery. Colotomy was performed, and the patient died three days later. At the autopsy there were signs of former ulceration in the rectum six inches from the anus, but none in the bowel higher up.

Description in catalogue: "Much thickened sigmoid, which is contracted to some extent; unduly rugose but practically normal mucosa. There is a very chronic perisigmoiditis, and a large mass of inflammatory tissue between it and the bladder; a small fistulous communication exists between them". This is an instructive and typical specimen; the thickened, stenosed, and rugose bowel, with two inches of inflammatory thick-

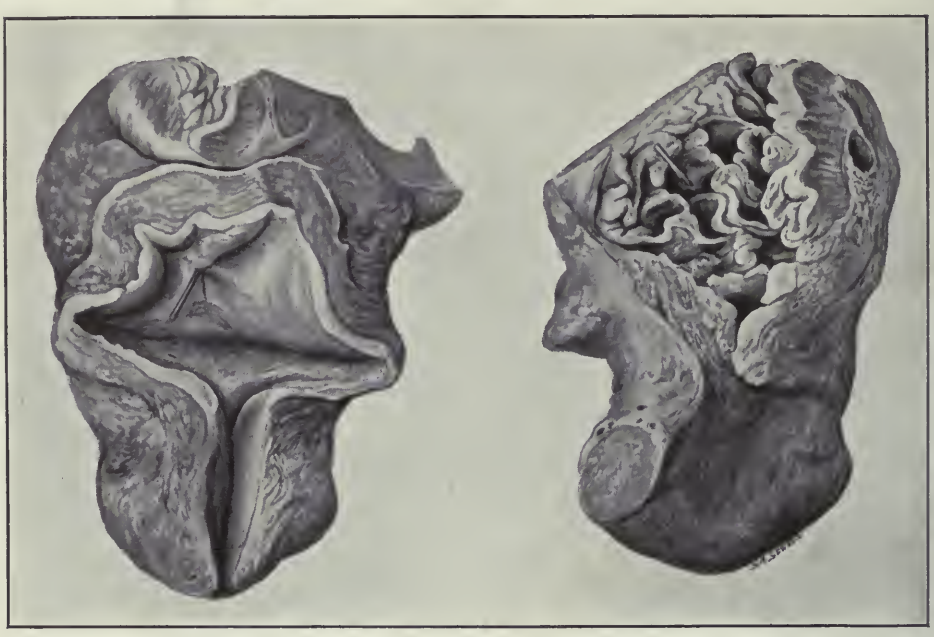

FIG. 59.—A case of vesicocolic fistula. (*No.* 945, *Guy's Hospital Museum.*)

ening between the bladder and the bowel. Into this can be seen extending in two or three places diverticular passages, cut more or less obliquely across, and lined with smooth mucous membrane. Beneath the rugæ, and not obvious until searched for with a probe, are the small orifices of many diverticula half an inch or more in depth. The fistula is a tortuous passage communicating with a small nut-sized abscess cavity.

SPECIMENS SHOWING THE EFFECTS OF GUNSHOT INJURY ON THE HEART AND BLOOD-VESSELS:

NOW ON EXHIBITION IN THE MUSEUM OF THE ROYAL COLLEGE OF SURGEONS OF ENGLAND.

By Sir GEORGE HENRY MAKINS.

In a previous issue of this journal,[1] some illustrations of the lesions of the blood-vessels resulting from gunshot injury will be found, and a further series appears in the writer's monograph on *Gunshot Injuries to the Blood-vessels*.[2]

The present communication contains a third series intended to supplement those which have already appeared, and to fill up some gaps in the pictorial delineation of the lesions concerned. All the specimens, depicted with admirable skill and exactitude by Mr. A. K. Maxwell, may be seen in the War Collection in the Museum of the Royal College of Surgeons. The specimens themselves exhibit the unrivalled skill of Mr. C. F. Beadles as a dissector.

INJURIES TO THE PERICARDIUM AND HEART.

Perforating injuries to the pericardium are not of rare occurrence; a large number are no doubt included amongst the class of case in which the position of the apertures of entry or exit renders it a source of surprise that the heart itself could have escaped injury. Many of these are of minor importance, they are accompanied by slight or by no symptoms, and, unless the heart itself has been scored, hæmorrhage may be minimal or absent. Even the sign of pericardial friction is not always detected in the minor injuries. The fact that missiles may enter the pericardial sac, become fixed, and cause but little trouble or distress, is founded on ancient observation, and the experience has been repeated in the late war. In other instances, however, a foreign body, although fixed in the pericardial sac, has been found to be a source of permanent irritation, giving rise to pain and disorder of the heart's action on exertion.

In the great war the foreign body, being so frequently a fragment of shell or bomb, has acquired a more weighty significance, since it has been a source of infection, and examination of the specimens in the collection shows how commonly pericarditis ended in death, where a wound by a bullet might have been followed by minor consequences. Naturally the heart escapes only when the wounds of the pericardium occupy the marginal area of the sac; when they occupy the more central portion the heart is commonly implicated.

Figs. 60 and 61 (W.O. 1486) illustrate an extreme instance of the escape of the heart from gross injury, even when the pericardium has suffered an extensive laceration in its central part. Such a lesion could only be produced by a fragment of shell travelling at a comparatively low degree of velocity; yet this specimen shows that very considerable force was exerted upon the sternum.

The patient, a gunner, age 25, was admitted into No. 7 Canadian General Hospital under Major Platt. The man was very ill. Two wounds were present: one of the left arm, the second an opening into the left side of the thorax an inch outside the heart. Respirations were rapid, the pulse weak and irregular. There was pus in the left pleura, and the cardiac dullness was increased in extent. Sixteen days later an attack of hæmorrhage occurred, and the man died the same day. The condition throughout

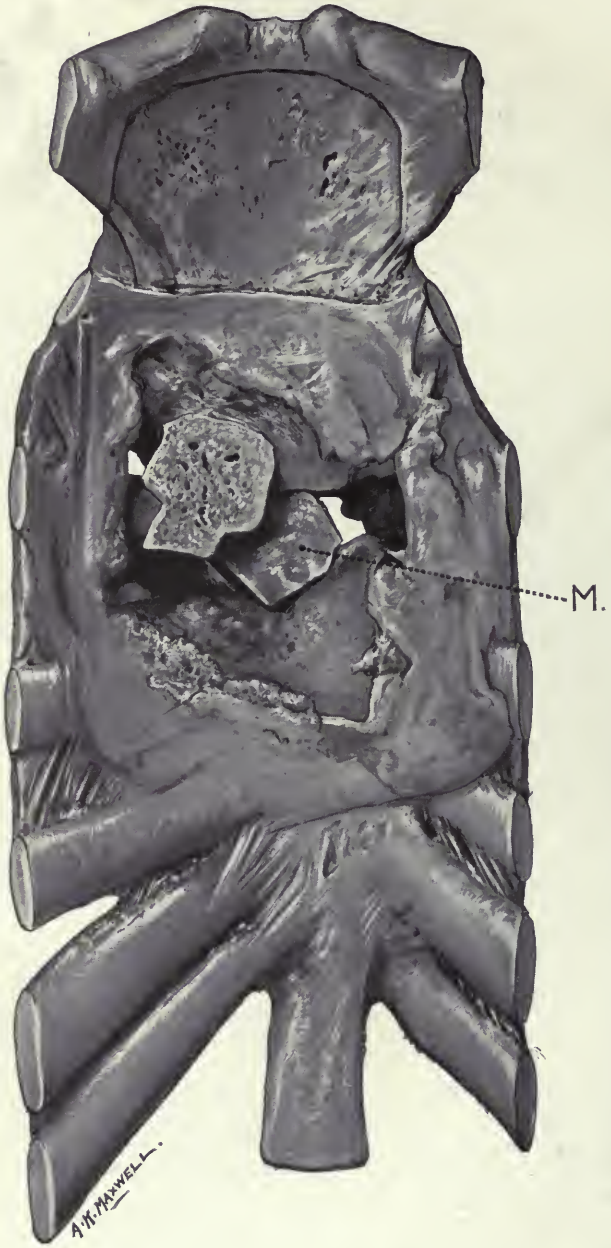

FIG. 60.—Comminuted fracture of sternum caused by a missile striking its posterior aspect.

FIG. 61.—Extensive laceration of the pericardium accompanying the fracture seen in *Fig.* 60.

had been so serious as to negative the question of submitting the patient to the strain incumbent on an *x*-ray examination.

At the autopsy the wound in the arm was found to have perforated the biceps without causing injury to the humerus. The aperture of entry in the chest wall was situated above the left nipple, and thence the missile had passed between the ribs and caused a comminuted fracture of the sternum at the level of the junction of the third costal cartilages. *Fig.* 60 shows the missile in position, and one large fragment of the comminuted fracture completely stripped of its coverings. The fracture extends over the entire width of the sternum. The fragment of the shell lay in relation to the right auricle of the heart, and a trifling injury to the wall of the right ventricle was evident while the specimen was in the fresh state. *Fig.* 61 shows the extent of the laceration of the pericardium. About three ounces of blood were present in the cavity of the sac at the time of the post-mortem examination. The lungs were engorged with blood, and the abdominal viscera soft and pale.

Some of the specimens show smaller lacerations of the pericardium produced by missiles which wounded it in passing without entering the sac.

W.O. 1678 illustrates the amount of injury which may be produced by a very small fragment. The mediastinal tissue on the outer surface is infiltrated by blood. When viewed from the inner aspect, a puncture sufficiently large to allow the passage of a fragment an eighth of an inch in diameter is surrounded by an irregularly circular area of subserous ecchymosis some four inches across. The anterior surface of the right ventricle is bruised, with subepicardial ecchymosis; there is a dent upon it, and a second dent on the posterior surface of the heart. The small missile lay in the posterior part of the pericardial sac. There was a small quantity of altered blood, and one 'shaggy' adhesion on the front of the heart. The patient from whom the specimen was removed lived twenty-two days, and died from pyæmia. There is no reason to believe he would not have recovered from the injury to the pericardium and heart.

WOUNDS OF THE HEART.

Fig. 62 (W.O. 657) illustrates a wound of the left ventricle of the heart. The specimen was obtained from a man who died shortly after admission to No. 13 General Hospital by Captain H. H. Henry.

A grazing tangential wound caused by a small fragment of shell was present in the left mid-axillary line. Widespread ecchymosis extended to the mid-line anteriorly, and downward to the anterior abdominal wall. The 4th and 5th ribs were fractured in the left mid-axillary line, with some comminution. There was a laceration of the left lung, with a few patches of fibrinous clot about the base of the left pleura, and one or two ounces of free fluid blood in the pleural cavity. No wound was discoverable in the pericardium, but an infected linear wound (see inset) about three-quarters of an inch long on the anterior wall of the left ventricle. The area around the wound showed septic ecchymoses, and there was slight pericarditis. Within the cavity of the ventricle a firm fibrinous clot occupies the site of the wound, and is firmly attached. In the specimen it has been sectioned. No vegetations are to be seen on the mitral valve.

The right lung, the liver, and the spleen were normal. Both kidneys showed septic infarcts, originating from the surface of the clot in the ventricle.

This specimen offers some difficult problems. The condition is readily explicable if we assume the passage of a small fragment of shell from the left side of the chest through the lung to the cavity of the left ventricle, whence it was carried into the general circulation. In fact, no track was found in the thoracic parietes, nor any opening in the pericardium. Further, no evidence of a foreign-body embolism is furnished. On the other hand, the wound in the heart was an infected one, which would seem to negative the idea that it could be the result of a rupture. I think the simple explanation must be accepted, and we must assume that the original track was rapidly obliterated.*

* In connection with this case, one reported by Messrs. G. R. Turner and Leslie Pearce Gould is of interest (*Lancet*, 1917, ii, 567).

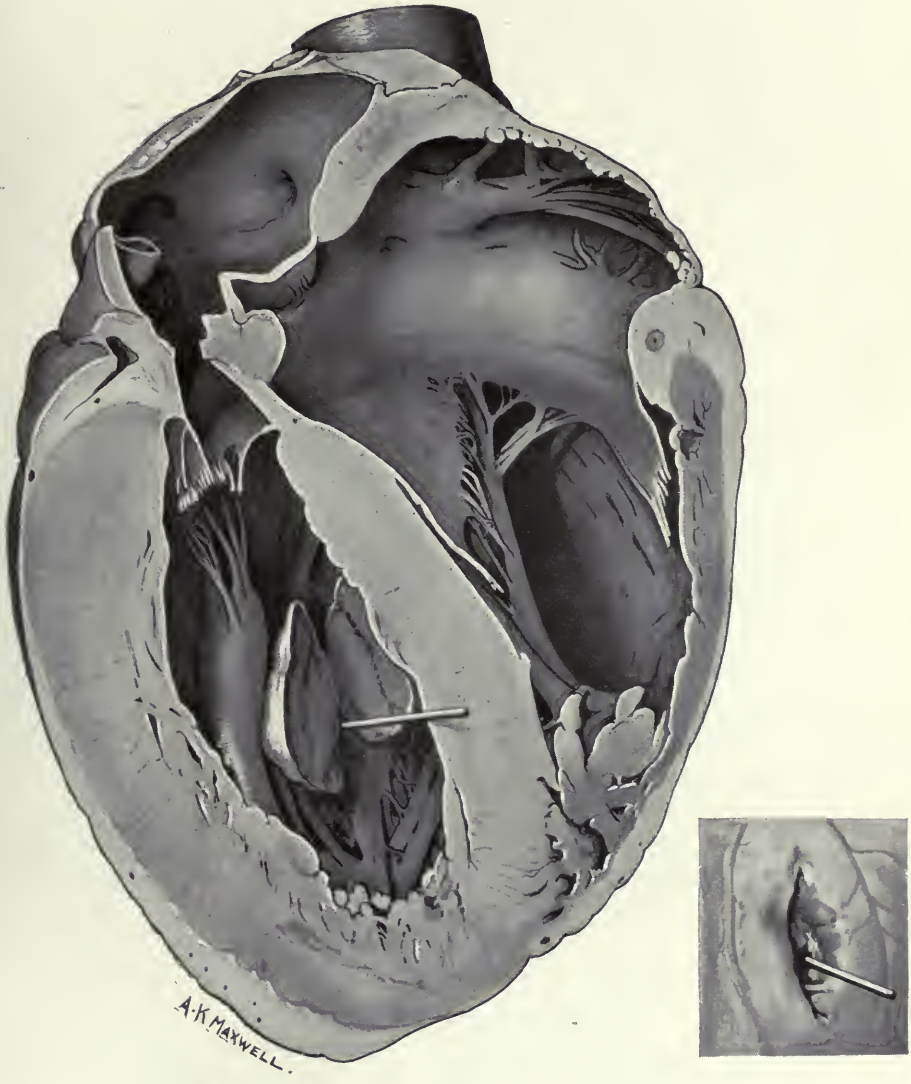

FIG. 62.—Wound of the left ventricle. Internal thrombus displayed by section. Inset: Wound as seen on surface of heart.

The most remarkable remaining feature is that no hæmorrhage had occurred into the pericardium, and that the wound in the wall of the heart became blocked by clot, while an internal thrombus formed, just as is the case in wounds of the large blood-vessels.

Fig. 63 (W.O. 571) furnishes another example of a perforating wound of the heart caused by a small fragment of shell. The missile entered the thorax from the abdomen, perforated the wall of the left ventricle just above the apex, grooved deeply the posterior wall of the ventricle, wounding the root of one of the papillary muscles, and after traversing the interventricular septum is seen to be lodged amongst the columnæ carneæ of the right ventricle.

It is noteworthy that in this instance but little trace of fibrinous clot has formed on the exposed surface of the cardiac muscle.

Fig. 64 (W.O. 2107) affords a remarkable example of an infected wound of the heart. The patient was wounded at 10 p.m., and admitted into No. 17 Casualty Clearing Station on the following day, under the care of Captain R. Bertram Blair. Two small wounds were found in the left mid-axillary line over the 5th and 6th intercostal spaces respectively. There was also an aperture of entry in the left lumbar region, and two entry wounds were present in the upper third of the left thigh.

Physical examination revealed dullness extending to the left scapula, and pericardial friction. The right chest was normal. On the third day an examination with the fluorescent screen showed a foreign body with a 'flail-like' movement, and also moving up and down with respiration, which was located to the chamber of the left ventricle. Half an hour after the man's return from the *x*-ray room the left lower extremity was noted to be blue and cold to above the level of the knee. The limb was raised upon a pillow, and after an interval of an hour regained its normal aspect.

On the fourth day the *x*-ray examination was repeated, and the foreign body, which had been located to the left ventricle, was now seen half an inch below and to the left of the umbilicus, i.e., at the point of bifurcation of the abdominal aorta. Nitrous oxide anæsthesia was induced, and fragments of shell were removed from the lumbar region and left thigh. The wounds were dirty, and suggested early 'gas gangrene'. The left pleura was aspirated and ten ounces of blood were drawn off. Cultures made from the blood proved negative. On the fifth day the man died from toxæmia due to anaerobic infection, and fifteen hours after death an autopsy was performed.

At this time there was emphysema of the face and neck. A small quantity of blood was found in the left pleura and in the pericardium. There was a hole at the lower and back part of the pericardium, and a fibrinous exudate clothed its anterior and left lateral wall. The small aperture of entry in the posterior wall of the left ventricle was found, and a ragged laceration on the surface of the interventricular septum. A jagged tear of the apex of one of the papillary muscles is also seen. The myocardium was very pale and full of gas bubbles. The foreign body was discovered at the bifurcation of the left common iliac artery, surrounded by dark-red blood-clot. The intima of neither the iliac artery nor the aorta had suffered any damage. A small hæmorrhagic infarct with indriven bone was found in the left lung, also apertures of entry and exit in the anterior portion of the lower lobe.

The illustration exhibits all these points. The infiltration of the myocardium with gas is no doubt a post-mortem development. The most striking features are the absence of any large quantity of blood in the pericardium although the patient lived five days, and the passage into the left iliac vessels of the fragment of shell which caused the wound. It may be remarked that the right iliac vessels are the more common recipient of travelling foreign bodies.

The next three specimens are of less clinical interest, since they represent fatal injuries; on the other hand, they illustrate the amount of destruction which the missiles of war are capable of producing.

Fig. 65 (W.O. 453) is of the greater interest. The patient, together with a second flying officer, were both struck by armour-piercing bullets. Both were dead when the aeroplane reached the ground, but this heart was that of the pilot, and the fact that the

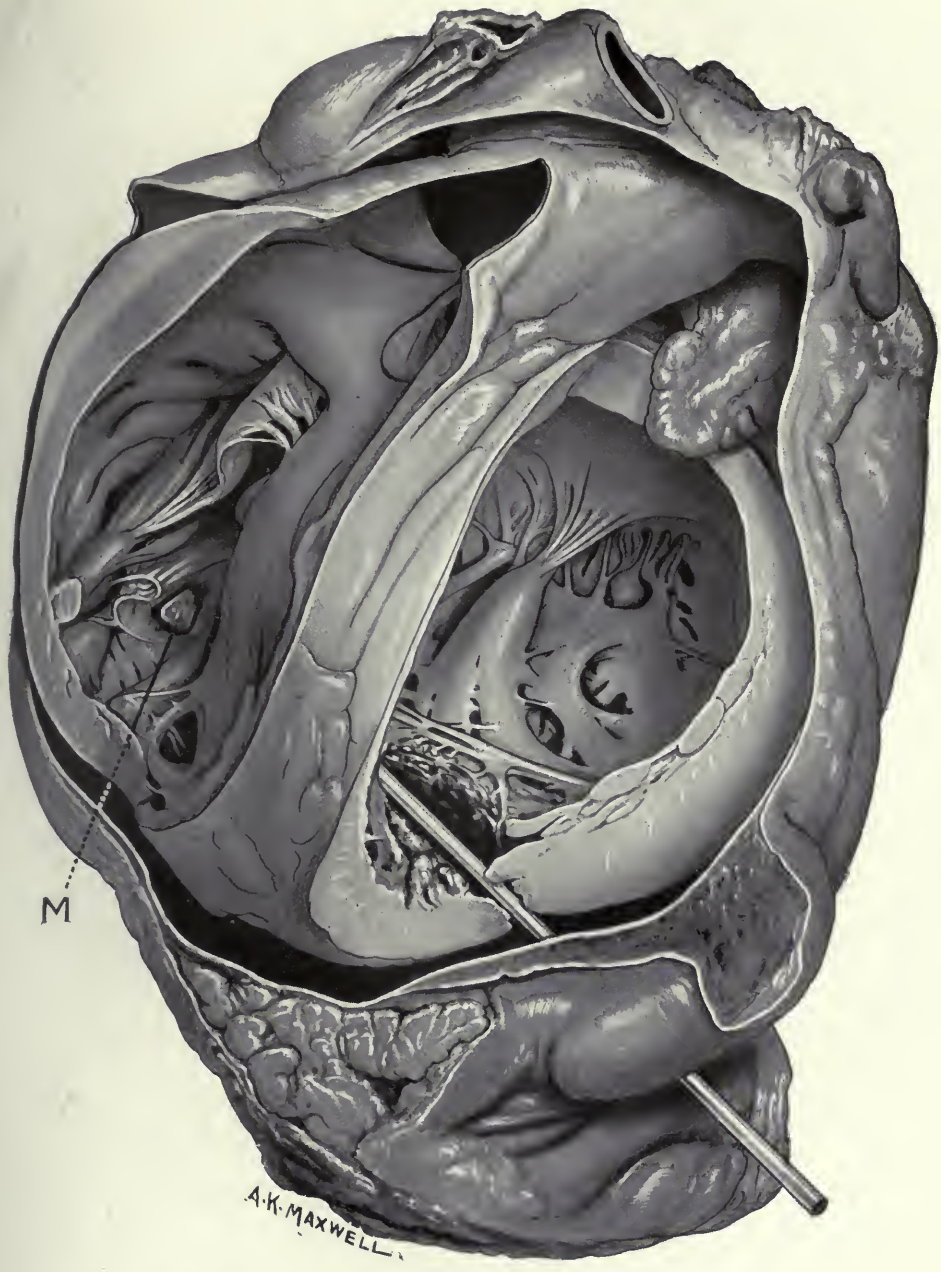

FIG. 63.—Perforating wound of heart, injury to base of papillary muscle. Missile (M) lodged in cavity of right ventricle.

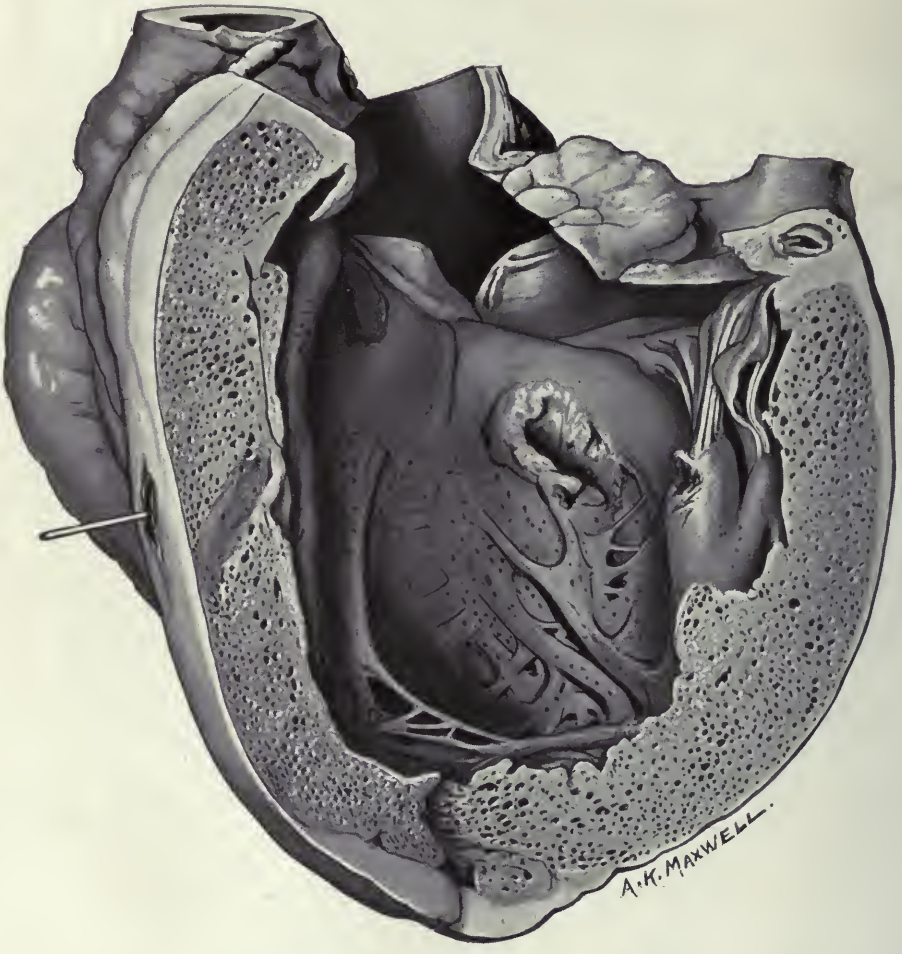

FIG. 64.—Perforating wound of left ventricle. Non-perforating wound of interventricular septum
Post-mortem extension of anaerobic infection in myocardium

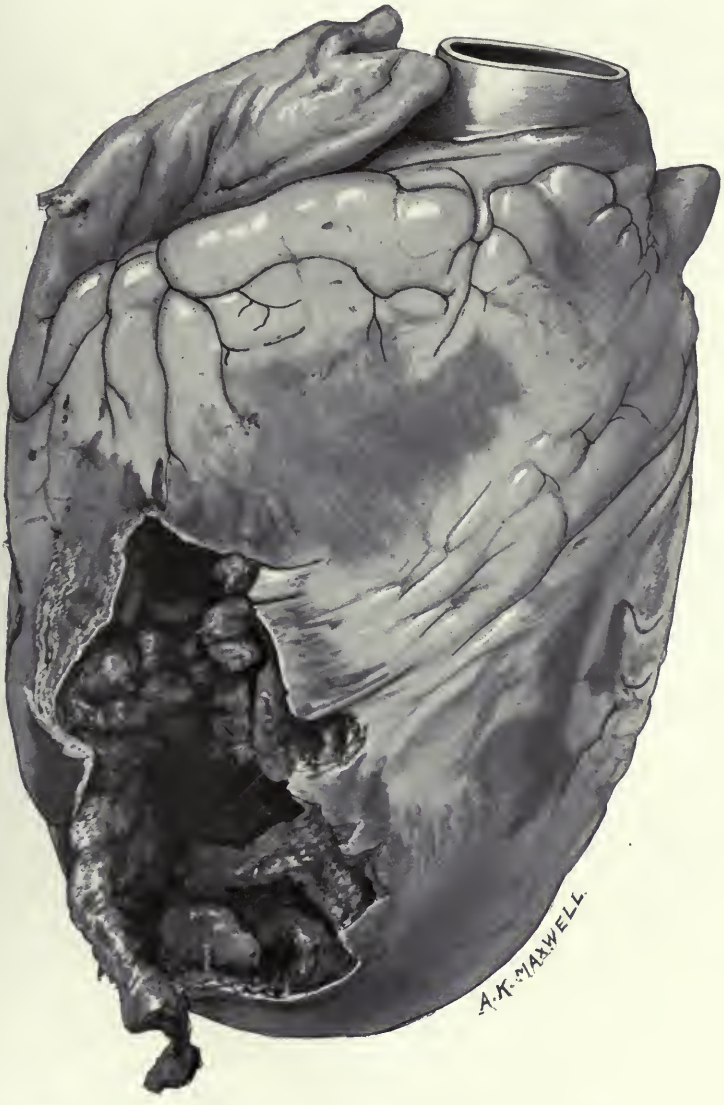

FIG. 65.—Serious limited destruction of myocardium produced by a deformed armour-piercing bullet.

machine was safely brought to a landing-place leads to the inference that in his case death was not immediate, in spite of the extent of the cardiac lesion.

As will be seen, the destruction of the myocardium is very extensive, and there is considerable subpericardial ecchymosis. The cavity of the ventricles is not impinged upon. Broken fragments of a bullet found in the machine suggest that the fatal missile may have struck some part of the plane and become deformed.

Fig. 66 (W.O. 2614) depicts a specimen secured by Captain T. H. G. Shore at the camp at Etaples, and is an example of a self-inflicted rifle wound. The muzzle of the rifle had been placed against the man's chest. The aperture of entry of the bullet, surrounded by an area of burned skin, was situated three inches above the left costal margin, one and a half inches within the left nipple line.

The bullet had traversed the heart, inflicting the injury depicted, and causing a large rent in the diaphragm through which the stomach was found prolapsed. The aorta was torn across immediately below the diaphragm, the left lobe of the liver was torn, and the bullet had injured the greater curvature of the stomach close to the œsophageal opening. The remaining abdominal viscera were uninjured. A little blood-clot was present in the left pleura, but the lung had escaped any damage. There was some hypertrophy of the left ventricle of the heart, and chronic nephritis of the type of the small white kidney. The aperture of exit, smaller than the entry wound and with everted edges, was situated in the right loin, one and a half inches from the mid-line.

At the post-mortem the remaining portion of the apex of the heart was found displaced upwards by the herniated stomach. It is impossible to say whether the heart was struck in a state of systole or diastole, but the specimen is the only one which raises the question of hydraulic explosive effect.

Inspection of the specimen appears to show some signs of contusion of the broken margin of the right ventricle ; otherwise the suggestion is of a more or less clean tear with radiating extensions, the widest of which is prolonged to the auriculoventricular groove. The comparison with the burst paper-bag inevitably arises, although the condition might be equally well produced by a combination of crushing and tearing, which would be in consonance with the expression 'blown away', employed in the original description of the specimen, and which would be the obvious explanation if the heart was struck during the period of contraction.

Fig. 67 (W.O. 530) illustrates the extreme severity, and yet the localization, of the injury which may be produced by a large fragment of shell. The wall of all four chambers of the heart is seen to be reduced to tatters ; yet the organ retains its general form and continuity.

The specimen was obtained from the body of a gunner who, while sitting on the limber only a few yards from the entrance to a casualty clearing station, was struck by a fragment of a shell which burst a few yards away from him. The missile traversed the sternum, damaged the heart as shown in the illustration, comminuted the vertebral column, and escaped from the back. The man fell in a pool of blood, and the heart was removed shortly afterwards by Lieut.-Colonel E. M. Cowell.

The above series of specimens is all of injuries to the ventricles, and it is a significant fact that the series of wounds of the auricle is much less numerous in the collection. It must, I think, be assumed that hæmorrhage is more likely to be abundant when the auricle is wounded. There is little chance that the gap in the wall can contract, and no possibility that the missile can plug the opening as is sometimes the case with the ventricle.

Some specimens in the collection, however, prove that death is not always an immediate result of wound of the auricle. Thus W.O. 2265 is a specimen removed from a man who was struck by a small fragment of shell over the 9th right rib. The patient was brought a distance of fifteen miles to a casualty clearing station, where the wound was explored and found to involve the diaphragm. The wound was excised, and the gap in the diaphragm closed by suture. Later on the same day death occurred.

At the autopsy the missile was found to have traversed the right auricle and lodged

FIG. 66.—Self-inflicted rifle-bullet injury to the heart. The appearances suggest hydraulic explosive effect.

FIG. 67.—Extreme laceration of the heart caused by a fragment of high-explosive shell.

FIG. 68.—Perforating wounds of the right auricle.

in the pericardial sac in the pouch beneath the pulmonary artery. No record was kept of the amount of blood found in the pericardial sac after death.

FIG. 69.—Direct extension of infection from a wound in the internal jugular vein to the heart.

W.O. 2108. This specimen was removed from the body of a man who died on the third day. When admitted to the casualty clearing station he was in a state of collapse. The fragment of shell entered the fourth right intercostal space one inch from the margin of the sternum. It perforated the anterior border of the lower lobe of the right lung, entered the right auricular appendix, and passing through the auriculoventricular opening was arrested in the apex of the right ventricle.

Death resulted from purulent pericarditis, and at the autopsy an antemortem clot occupied the right auricle, extending through the tricuspid opening into the right ventricle, almost blocking the passage.

In a third case, W.O. 1921, a fragment of shell entered at the pectoral fold, fractured the 3rd rib, passed through the upper lobe of the left lung, perforated the pericardium, and gave rise to a rounded laceration of the wall of the left auricle at the base of the auricular appendix. After death the missile was found in the left pleural sac, which was full of blood. The missile therefore appears in passing to have perforated both the pericardium and the auricle without actually entering the sac. No record was furnished as to the date of death, nor as to the amount of blood found in the pericardium.

A fourth specimen (*Fig.* 68) (W.O. 1405) was used by Captain Cowell to illustrate the occurrence of death from shock. The patient, a German private, was wounded by a bullet which produced three rounded holes in the right auricle, each large enough to admit a pencil. Two ounces of fluid blood were found in the pericardium; the right ventricle was contracted and empty. The face of the patient was cyanosed.

A general survey of these specimens throws light on some of the problems of injuries to the heart which have often been discussed.

In the first place, abundant proof is furnished that the heart may sustain very severe injury without causing the immediate death of the patient. In fact, in only three of the cases here quoted did immediate

death result: in two from actual destruction of the organ, and in the third from shock. In the latter, however, the amount of injury to the auricle was so great that further action of the heart would have been impossible. It must be remembered, too, that these specimens were practically all obtained from hospitals, and probably represent the proportionately few patients who survived the injury.

The specimens delineated in *Figs.* 62, 63, and 64 also show that considerable perforating wounds of the ventricle may occur without serious hæmorrhage into the pericardial sac resulting; in the case shown in *Fig.* 62 absolutely none occurred. This is generally to be explained by contraction of the opening by the muscle of the heart and the deposition of clot in the track; in some cases possibly by the impaction of the missile in the opening (W.O. 2522).

In relation to these remarks it will be observed that all but two of the injuries here figured were produced by fragments of shell, and that the latter were in most instances retained, an evidence of a low degree of velocity and striking force on the part of the missile. We know also that bullets travelling with a low degree of velocity may be retained in the wall of the heart without causing death. The two exceptions are those of the wound of the auricle referred to, and the self-inflicted rifle wound, in which the destruction produced was extensive.

While, therefore, there is little reason to doubt the common occurrence of death from shock when the heart is hit, the general weight of evidence is in favour of a more common escape from immediate death than has been commonly held to be the case. It seems probable that in many of the instances in which the position of the apertures of entry or exit of bullets suggests that the heart has been wounded, and in which, from the absence of symptoms, we have concluded that the organ has escaped injury, we have not had tenable ground for the assumption. The specimens of injury to the ventricle at any rate strongly support this opinion. They further show that, in cases of injury by fragments of shell, pericarditis of an infective character is the most frequent cause of death.

Fig. 69 (W.O. 2209) is appended to this series to illustrate the direct extension of an infection from a wound in the neck to the endocardium.

The patient was wounded by a shrapnel ball which entered just above and outside the left angle of the mouth, fractured two bicuspid teeth, and passed by the left side of the tongue into the right anterior triangle of the neck, where it was retained. A few days later the shrapnel ball was removed from a small septic cavity in direct relation to the right internal jugular vein. A little venous bleeding followed, but was readily controlled. The man died at the end of the month as a result of general infection. The wound on the right side of the neck was in a septic condition, and the cavity was connected with the internal jugular vein. The vein was thrombosed from this spot down to the valve at its root. Beyond this point the lumen was occupied by post-mortem clot, with a small strand of adherent ante-mortem clot in its midst.

It will be seen that the right auricle is distended with recent dark blood-clot, while around the tricuspid opening, and upon the valves, are massive vegetations. The remains of the septic cavity in the neck, and its connection with the jugular vein, are indicated in the drawing by a glass rod. In the lungs were a number of septic infarcts. The liver was pale and fatty, the spleen was soft, and the kidneys were pale; these viscera exhibiting the common characters of those met with in cases of general infection.

INJURIES TO THE BLOOD-VESSELS.

A series of illustrations depicting both the gross appearances and the histological details of the types of contusion produced by gunshot injury will be found between pages 9 and 15 of the monograph already referred to.[2]

Fig. 70 (W.O. 1945) is inserted to complete the series by a specimen showing one of the slightest types, that in which a contusion is accompanied by the formation of small fissures in the intima, such breaches of surface becoming clothed by coagulum and thus furnishing a potential source of peripheral emboli. The specimen was obtained from the

body of a man who died on the fifth day as a result of a wound caused by a fragment of an aeroplane bomb.

The missile entered the body below the middle of the 12th rib upon the left side. Thence it entered the abdomen, cut a deep groove in the posterior surface of the left kidney; then crossed and bruised the aorta just above the origin of the inferior mesenteric artery, passed through the lower edge of the head of the panereas, and entered the stomach in the neighbourhood of the pylorus. The fragment of bomb was vomited by the man three hours after reception of the injury. At the autopsy an acute ulcer was found on the anterior wall of the stomach just above the greater curvature, three inches from the pylorus. The ulcer was three-quarters of an inch in diameter, it had soft clean-cut edges, and the floor was formed by the exposed muscular coat. The drawing shows well the result of the contusion of the aorta.

FIG. 70.—Contusion of abdominal aorta. Fissuring of intima, with minimal deposition of clot.

The next series consists of specimens of foreign bodies either impacted, or forming artificial emboli and thus obstructing the blood-stream.

Obstruction of the blood-stream by pressure of impacted missiles from without the vessels, with or without gross damage to the wall, are familiar enough to the surgeon. Such missiles occasionally become permanently incorporated in the vessels and entirely occlude them. An example from the practice of Sir Charters Symonds is figured on page 16 of my monograph (*Fig.* 7).

FIG. 71.—Transfixion of femoral artery by a flattened machine-gun bullet.

Fig. 71 (W.O. 1922) shows a flattened machine-gun bullet which has transfixed the femoral artery in the lower portion of Hunter's canal. The patient had received severe flesh wounds of the left forearm and right thigh. A foreign body could be felt at the lower end of one of the tracks in the thigh. Captain Hood cut down on this, and found the femoral artery as depicted. No local hæmorrhage had occurred, and the femoral vein had escaped damage. No tibial pulse could be detected in either limb.

FIG. 72.—German bullet in external iliac artery, base downwards.

The portion of artery was exeised, and the vessel ligatured above and below.

Fig. 72 (W.O. 2413) depiets a regulation German bullet lying base downwards in the right external iliae artery, the body of the missile lying across the origin of the internal iliae, and its point still in the eonmon trunk.

The bullet entered the thorax, traversed the lung, and perforated the thoracic aorta. (An illustration of the slit wound of the aorta is seen in *Fig.* 33, p. 114, of my monograph). The injury to the lung resulted in the formation of a large hæmothorax, from which four pints of blood were evaeuated at the end of twenty-four hours. The wound of the aorta was surrounded by some interstitial mediastinal hæmorrhage of very moderate degree. The patient died on the fifth day as a result of an acute streptocoeeus infeetion of the pleura.

It will be noted that a thrombus an inch and a quarter in length at either end of the bullet eompletely obstructs the common and external iliae arteries. The embolus does not appear to have given rise to any threatening symptoms. The specimen was seeured by Captain Adrian Stokes. There seems little doubt that the wound of the aorta was a negligible faetor in this case.

Figs. 73 and 74 (W.O. 3071) are of one of the most remarkable instanees of a travelling bullet ever put upon record. A full history of the case by Captain H. J. B. Fry will be found in the *Lancet*.[3]

The bullet entered half an inch below the left anterior superior spine by a small oval wound. It wounded the baek of the left external iliae artery and then entered the satellite vein. Thence it was carried by the blood-stream to the right auricle, traversed the ventriele, the pulmonary valve, and pulmonary artery, to enter its left branch, and eventually beeome impacted in one of the branches supplying the lower lobe of the left lung, in which it gave rise to two infarets.

The patient, when admitted, stated that he had felt a sharp stinging pain in the left foot when hit, and assumed that the wound was in that position. The left limb was eold, œdematous, and painful; the foot was puffy and diseoloured, and there was neither a palpable peripheral pulse nor any capillary reaction. A humming murmur was heard, and a palpable thrill was detected below and to the left of the umbilicus. No evidence of a retained foreign body was obtained by an *x*-ray examination of the area of the body between the umbilicus and the knees.

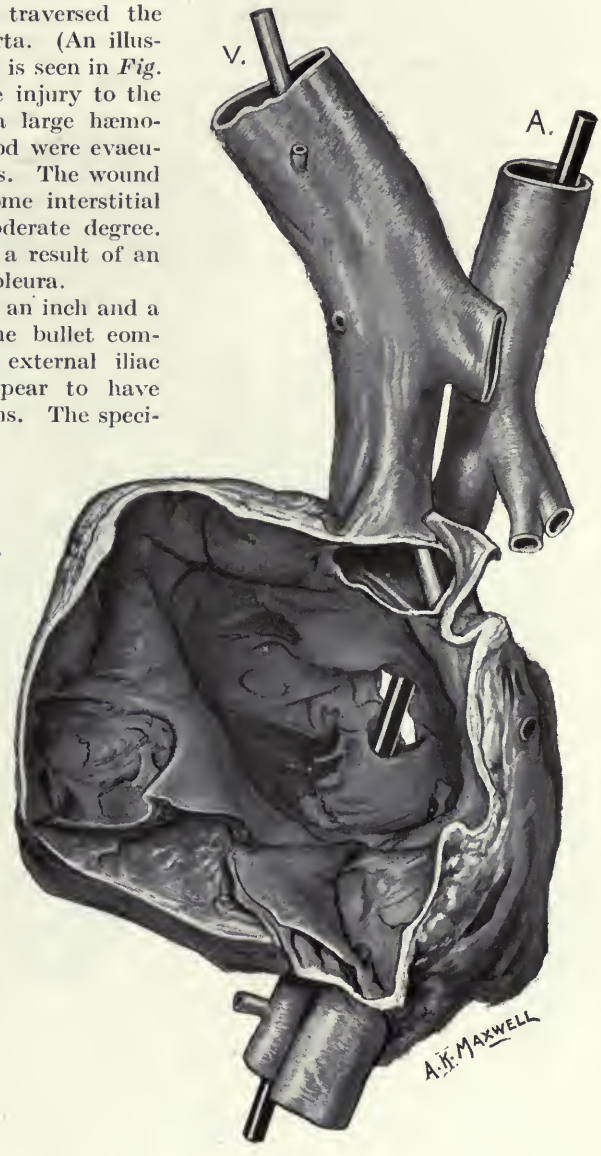

FIG. 73.—Arteriovenous hæmatoma in connection with the external iliac vessels. Separate openings of artery and vein.

Captain Fry gives the following clinical history :—

For a week the patient's general condition remained good. There was some collapse of the bases of both lungs. A 'hæmic' systolic murmur was present at the apex of the heart, and it was especially loud in the pulmonary area. The pulse was rapid (136), full, and soft ; blood-pressure 95 to 100 mm. Hg ; respirations rapid (36) and shallow. There was a slight icteric tinge of the skin of the face and conjunctivæ, and considerable œdema of the back. Urine showed a faint trace of albumin, a few urinary epithelial cells, and one or two degenerated granular casts. The day after its receipt the wound was almost healed and the ecchymosis of the loin had

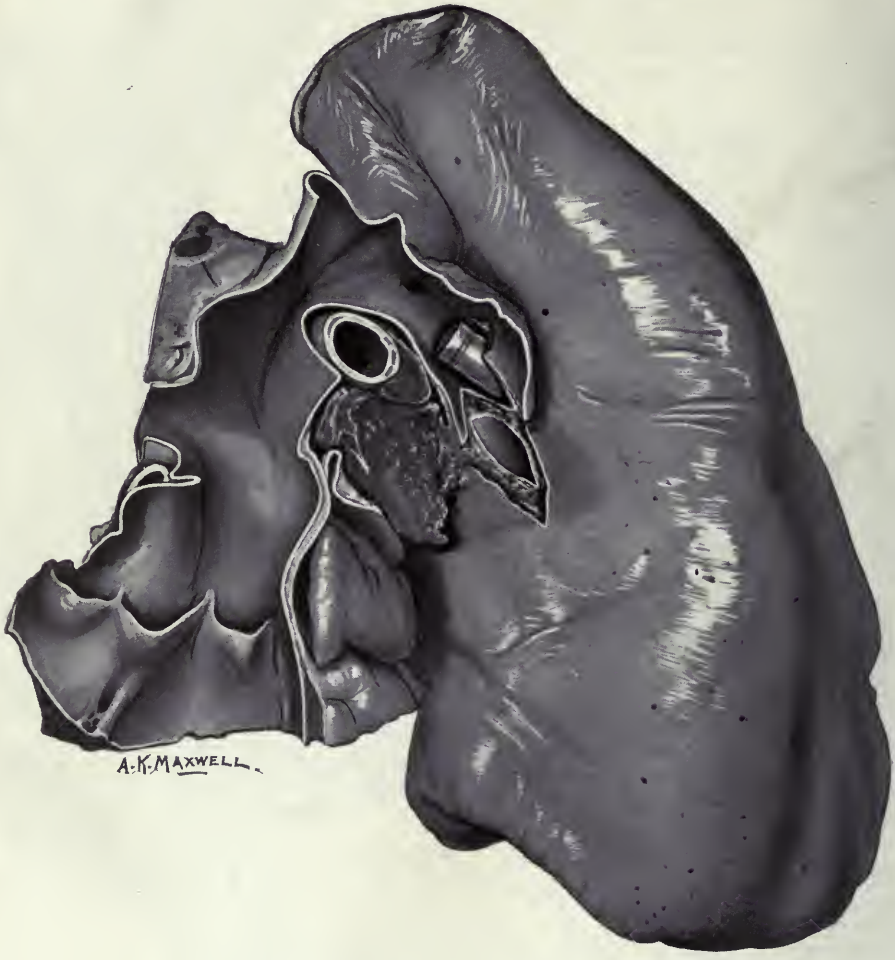

FIG. 74.—Bullet which travelled from the left external iliac vein, impacted in one of the branches of the left pulmonary artery.

disappeared, but gangrene of the left leg was complete, and the leg was therefore amputated below the knee by Captain Le Mesurier.

The patient's condition improved for a short time, but in a few days the amputation stump became gangrenous. A booming cavernous note was detected in the aneurysmal murmur, and respiration, which had always been shallow and rapid, became gasping and very rapid, with a greatly increased pulse-rate. Finally, the patient became delirious, the pulse uncountable, and respiration-rate rose to 60 to 70. The temperature steadily mounted, and the patient gradually sank, and died in coma, one month after receipt of the wound.

At the autopsy there was widespread retroperitoneal ecchymosis, and a large aneurysmal sac. The aorta appeared contracted and rather shrunken ; the left common iliac artery was small. Both vessels contained a little recent clot. The inferior vena cava was large and dilated, as were also the renal and common iliac veins, especially the left. The left femoral artery was small, collapsed, and empty, but the femoral and internal saphenous veins were large and thrombosed. On removal, the left external iliac artery was found to communicate with the aneurysmal sac by an opening on its posterior surface immediately below the origin of the internal iliac (*Fig.* 73). The artery was patent both above and below. The external iliac vein opened into the front of the sac by a separate opening at a somewhat higher level. The vein was thrombosed below this opening, so that arterial blood entering the sac at once passed backwards into the venous circulation.

The bullet which had caused the injury was discovered in the branch of the left pulmonary artery passing to the lower lobe. The lumen of this vessel and a smaller lateral branch were completely blocked, and two infarcts in the lung corresponded with the peripheral distribution of the occluded branches.

Captain Fry states that "from measurements *in situ* and standard measurements, the distance travelled by the bullet in the blood-stream was not less than two feet. Since the blood-pressure in the inferior vena cava in the normal condition is about + 3 mm. Hg, and diminishes in the veins of the chest and the right auricle to − 8 mm. Hg, while the velocity of the circulation is not above 25 cm. per second, it is probable that the blood-pressure in the abdominal veins must have been greatly increased through the formation of the arteriovenous aneurysm, to have enabled the venous flow to sweep such a comparatively heavy weight as 10 grm. along the veins. The condition, indeed, was one in which the patient was bleeding into his venous circulation."

The same departure from the normal condition has been seen to be the explanation of gangrene of the foot resulting from simple proximal ligature of the femoral artery in femoral and popliteal arteriovenous aneurysms.[4]

Specimen W.O. 1791 shows a small piece of shell, lodged in the apex of the cavity of the right ventricle of the heart, which entered the circulation by perforating the inferior vena cava.

Fig. 75 (W.O. 2208) represents the common iliac artery blocked by half a shrapnel ball. The patient, age 35, was struck in the posterior right axillary line, the ball entering the chest. There was much ecchymosis over the lower ribs behind, and subcutaneous emphysema around the wound. When admitted to hospital the man's colour was good ; there was slight dyspnœa. The heart was normal. On the eighteenth day the condition was improved, and an *x*-ray examination of the chest showed no sign of a foreign body. The following day a sudden attack of pain was followed by death. No mention is made of any sign of obstruction of the iliac artery.

FIG. 75.—Broken shrapnel ball occluding left common iliac artery.

At the autopsy, performed by Captain Shore, two or three ounces of fluid, with large blood-clots of evident recent origin, were found in the right pleural cavity, and there was a bullet track in the right lower lobe of the lung, along which spicules of the 7th rib were distributed. The right upper lobe showed bronchopneumonia ; the lower lobe was

collapsed. A thin-walled false aneurysmal sac in connection with a large wound of the aorta, two inches below the arch, projected into the left pleural sac. No definite rupture of the sac could be discovered.

FIG. 76. — Fragment of shell occluding left external iliac artery.

The shrapnel ball is seen in position, with a proximal clot extending backward to the bifurcation of the abdominal aorta. The viscera were healthy.

Fig. 76 (W.O. 2107*a*) is included to complete the varieties of missile which may form emboli. This specimen is that already referred to in the history of the case of infected wound of the heart (*Fig.* 64, p. 114).

TRAUMATIC ANEURYSMS.

The following six drawings illustrate points in the mode of formation and the structure of traumatic aneurysms.

Fig. 73, already dealt with, is an excellent example of a large arteriovenous aneurysm, into the sac of which the two vessels open quite independently, and in which the distal end of the vein is completely thrombosed. In my own experience the latter is an arrangement rarely seen unless the vein has suffered complete severance. This iliac aneurysm is also probably one of those in which the original arterial hæmatoma has remained fluid from the date of the primary injury. A remark will again be made upon this subject in connection with *Figs.* 77 and 78.

FIG. 77.—Wound of abdominal aorta, with remains of sac of arterial hæmatoma.

Fig. 77 (W.O. 2677) shows an extensive obliquely tranverse wound of the aorta between the origins of the superior and inferior mesenteric arteries. Attention is called to the site of the attachment of the walls of the hæmatoma at some distance from the actual wound of the artery, a condition again suggesting that we have here to deal with the wall of an early arterial hæmatoma, for in a fully-developed false traumatic aneurysm the margin of the sac corresponds exactly with that of the aperture in the wall of the artery. The patient from whom this specimen was removed had suffered very extensive injuries. There was a wound of the left side of the thorax through the 7th rib, whence the bullet passed through the diaphragm, wounded the left lobe of the liver, and finally the front aspect of the abdominal aorta below the superior mesenteric artery. A second bullet entered the left leg and caused a comminuted fracture of the patella.

The man was admitted into the field ambulance the day after he was wounded, and thence was sent down the line, and eventually to England, during the strenuous times of April, 1918. He arrived in No. 16 Canadian General Hospital on the seventh day, in fair condition; the chest wound was healing well, but the wound of the knee-joint had become infected and was suppurating. A collection was diagnosed in the left pleural sac; this was aspirated, and about twenty-five ounces of bloody fluid were evacuated. The patient gradually lost ground, and died on the sixteenth day after reception of the injuries, as a result of loss of blood and toxæmia.

At the autopsy the visceral lesions already enumerated were discovered, also a small omental hernia through the rent in the diaphragm. There was very copious retroperitoneal hæmorrhage, extending from the upper border of the kidney along the line of the ascending colon to the pelvis. The pelvis was filled with blood, and a sac with walls of clot three to four inches in thickness had formed in connection with the wound of the aorta.

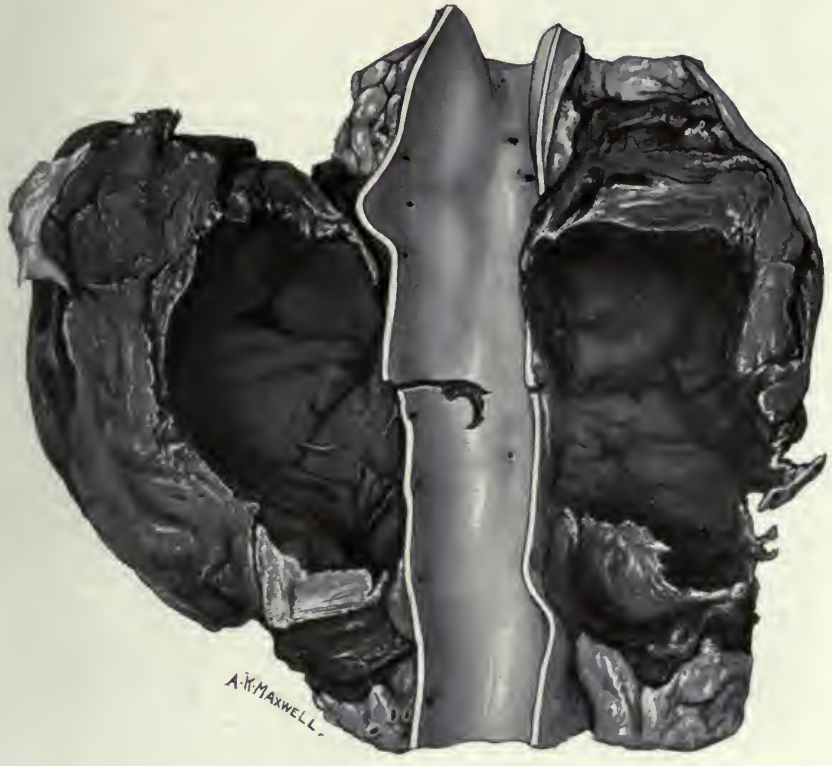

FIG. 78.—Arterial hæmatoma in connection with a wound of the thoracic aorta.

Fig. 78 (W.O. 2208) is an excellent example of a large arterial hæmatoma in connection with the thoracic aorta. This and the preceding specimen are both remarkable in illustrating how large a rent may be made in a great trunk vessel without leading to rapid death. In this specimen the widespread attachment of the sac to the outer surface of the vessel is a still more prominent feature than in that shown in *Fig.* 77. In this instance also, the cavity of the sac probably represents the original pool of blood which formed when the vessel was injured, while the wall of the sac is formed by blood-clot deposited at the periphery, and layers of mediastinal connective tissue stiffened by hæmorrhagic infiltration.

The retroperitoneal site is that in which such large pools of blood are most frequently

met with, but in spite of the fact that the patients may survive for many days, a fully-developed traumatic aneurysm has never been seen by the writer in connection with the abdominal aorta. In the smaller perforating wounds which have come under observation some time after reception of the injury, limited retroperitoneal ecchymosis only has been found, and no trace of sac formation.

Fig. 79 (W.O. 2546). An aneurysm in connection with an extensive transverse slit in the posterior surface of the thoracic aorta near its commencement. The patient survived a series of very serious injuries for a period of thirty-seven days. Struck by fragments of a bomb, he received multiple wounds in the back and buttocks. For four days after the injury he lay out in no-man's land, and when brought into hospital he was suffering with 'trench' hands and feet. On the ninth day several fingers and both feet were amputated for gangrene. The wounds in the back and buttocks were infected, but going on well. On the twenty-eighth day he complained of severe pain in the chest ('deep in'). The pain was increased on swallowing, and the temperature rose to 101·4°. From this period the temperature remained high, and the pain in the chest continued. On the thirty-seventh day a sudden violent hæmorrhage occurred, blood escaping by the mouth, and the patient died.

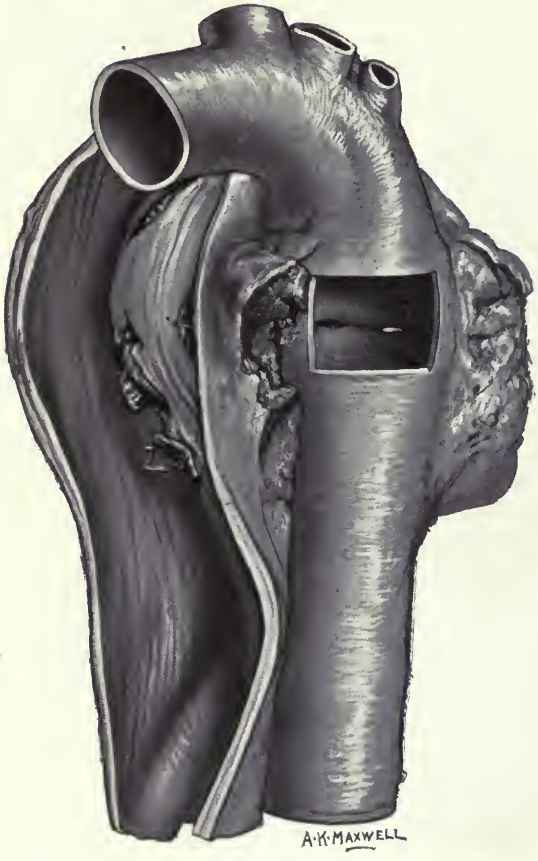

FIG. 79.—False aneurysm of thoracic aorta. Œsophageal ulceration and perforation of wall of sac.

At the autopsy the amputation stumps were granulating. About half a pint of turbid fluid was present in each pleura; on the left side there was much plastic exudation. The lungs were œdematous but not pneumonic. The heart was dilated, but there was no valvular disease. The solid abdominal viscera were in the condition characteristic of general septic absorption. The stomach was distended with recent blood-clot, but otherwise normal. The œsophagus was normal in the lower third, but bulged forward prominently behind the bifurcation of the trachea. At the bulging portion the wall of the œsophagus, when displayed from within, exhibited three rents, as seen in the illustration. These rents led to a thick-walled cavity filled with clot and communicating with the interior of the aorta by a slit-like orifice. Captain Shore speaks of the cavity as 'apparently inflammatory', but regarded it as a false aneurysm.

The specimen appears to illustrate the comparatively rare sequence of secondary infection of an aneurysm, in all probability occurring as a complication of ulceration of the surface of the œsophageal wall where bulged inwards by the prominence of the sac.

Some remarks have been made elsewhere as to the resistance of traumatic aneurysms to infection, and the next case affords an illustration of this point.

Fig. 80 (W.O. 1311). Traumatic femoral aneurysm in Hunter's canal. The specimen was obtained by Captain Hamilton from the body of a man, age 19. The patient was the subject of multiple wounds (arms, forearms, legs, thighs, and right buttock) caused by fragments of a hand grenade. The numerous wounds were subjected to operative cleansing on the day they were received, and treated by the Carrel-Dakin method. Before the operation it was noted that the posterior tibial pulse was absent. Eight days later the man complained of pain in the right thigh, and examination disclosed an oval expansile tumour at the lower end of Hunter's canal. Four days later the swelling had decreased in size and the posterior tibial pulse was palpable. During the next fortnight little change occurred, except that the aneurysm became firmer and less expansile. The man died on the twenty-seventh day from septicæmia, which accompanied an atypical inflammatory condition of the right arm, characterized by 'solid' œdema.

The drawing sufficiently explains itself, but it has been included to illustrate the part taken by the sartorius muscle in the formation of the sac. In the quite recent state, the incorporation of the muscle as almost an integral constituent in the wall was still more apparent. That expansion and incorporation of nerves are a more important characteristic of these aneurysms is a common observation.

FIG. 80.—Incorporation of sartorius muscle in the wall of a femoral aneurysm.

FIG. 81.—Bilateral false aneurysmal sacs in connection with the femoral artery.

One other point of importance was illustrated by this case. At the autopsy an abscess enclosing the piece of the grenade which had wounded the artery was found in direct continuity with the wall of the aneurysm. Yet the wall itself was not involved by the infection. Even in cases of diffuse cellulitis it is remarkable what a long period may continue in which the wall of the aneurysm may form an effectual barrier to the spread of infection.

Fig. 81 (W.O. 1089). A specimen of symmetrical aneurysmal sacs forming in connection with either opening of a traversing wound of the left popliteal artery. The aneurysm was dissected out by Major J. R. Lee

about seven months after the receipt of the injury. The patient had complained of pain and swelling of the limb, aggravated by exercise for the four weeks prior to the operation. It will be noted that the popliteal vein escaped injury, but it was no doubt pressed upon by the aneurysm, as were also the external and internal popliteal nerves.

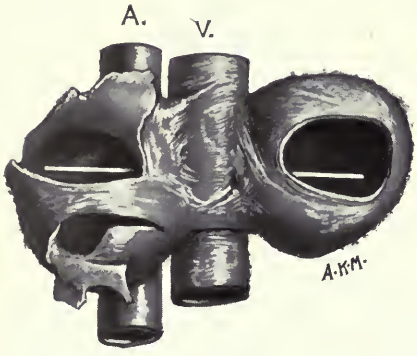

FIG. 82. — Arteriovenous aneurysm and aneurysmal varix. A sac has formed in connection with both the venous and arterial wounds on the free aspect of the vessels.

Fig. 82 (W.O. 3496). A specimen in which a perforation of the popliteal artery and vein has been followed by the formation of a sac in connection with each vessel. The writer believes this to be an uncommon condition, because this is the only instance in which it has come under his personal observation. The formation of a sac in connection with the opening in the vein has, however, been described by other authors.

In the immense majority of such injuries the distal wound in the vein closes and heals spontaneously, and only the wound in direct proximity to the artery remains patent. This is obviously due to the fact that the pressure of the arterial current is at once lowered by the passage of the blood into the lumen of the vein, and the blood tends to take that course rather than to overcome the resistance of the tissues supporting the vein and form a sac.

The last three illustrations belong to neither of the former classes.

Fig. 83 (W.O. 204) shows a perforating wound of the inferior vena cava. The bullet entered the abdomen three inches above and to the right of the umbilicus, and wounded the transverse colon and the third part of the duodenum. The injuries to the intestine were repaired by suture. The man lived thirty hours after the operation, and then died suddenly from no obvious cause.

FIG. 83.—Traversing wound of the inferior vena cava.

At the autopsy only a moderate retroperitoneal hæmorrhage was disclosed, but the wound of the cava, with free flaps suggesting tearing by a missile travelling with a low velocity, was found, and also the bullet itself impacted in the 4th lumbar vertebra, base forwards.

Fig. 84 (W.O. 647*a*). This illustrates thrombosis of the right Sylvian artery, secondary to embolism following a wound of the common carotid artery. A drawing of the wounded artery appears in my monograph (*Fig.* 21, p. 58).

The localized cylindrical clot, about an inch in length, attached to the wound in the wall of the artery, is seen to have already contracted sufficiently to allow of partial re-establishment of the circulation. A large clot one inch in diameter lies in the vascular cleft on the outer aspect of the vessel.

At the autopsy much bleeding was found to have taken place into the neck, and the missile, a small fragment of a bomb, was discovered embedded in the thyroid gland. The specimen was obtained by Captain McNee.

Fig. 85 (W.O. 2899) is not illustrative of gunshot injury, but it is a very remarkable example of rupture of the aorta. The specimen was obtained from the body of an airman whose machine crashed from an altitude of about five hundred feet. The pilot was in a

more or less sitting posture. An enumeration of the injuries found by Captain Shore at the autopsy will suffice to show the degree of force to which the body had been submitted.

There were many wounds about the head, fragments of wood were found driven into the ear, the lower teeth had perforated the lip, and a diffuse subdural hæmorrhage was discovered when the skull was opened. There was a small fissure in the cribriform plate of the ethmoid, but no other fracture of the skull. The right humerus and the right femur were fractured. There was a deep track in the perineum not involving the peritoneum, and another in the left groin. The 2nd, 3rd, and 4th left ribs were fractured; a pint of blood was found in each pleural cavity, and there was a laceration of the left lung. Much bruising of the mediastinal tissue had occurred, and there were subpelvic hæmorrhages in the left kidney. The remaining viscera were uninjured.

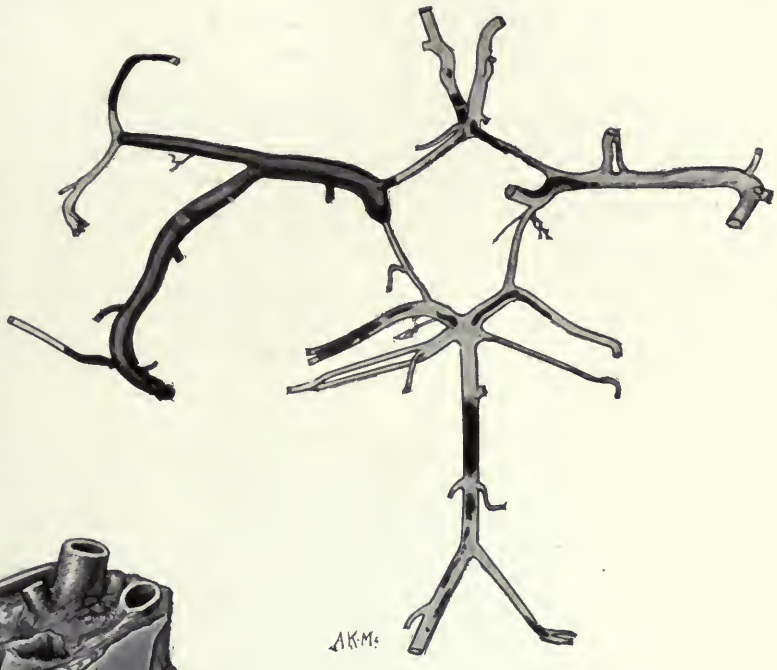

FIG. 84.—Thrombosis of right Sylvian artery, in connection with a wound of the common carotid artery.

FIG. 85.—Double rupture of the arch of the aorta.

The drawing shows the remarkable injury to the aorta, which has suffered two practically complete severances of continuity, one immediately beyond its origin, the second at the commencement of the descending part. A rupture of the pulmonary artery had also been produced, but the vessel was unfortunately severed during the removal of the lungs before the injury

was discovered. Little comment can be made on this specimen, beyond hazarding the suggestion that the injury was the result of hyperextension of the neck and shoulders. In spite of the fact that the man was probably in a sitting posture, it does not seem possible that doubling up of the body could have produced the lesions found.

Readers of the JOURNAL have cause for warm appreciation of the energy and discrimination which were shown by Capt. T. H. G. Shore, Captain Adrian Stokes, Captain H. Henry, Captain McNee, Captain Cowell, and others, in the selection and preservation of the magnificent collection of specimens from which the illustrations in this article have been culled.

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[1] *Brit. Jour. Surg.*, 1916, xi, 353.
[2] MAKINS, *Gunshot Injuries to the Blood-vessels* (John Wright & Sons Ltd., 1919).
[3] *Lancet*, 1920, i, 13.
[5] MAKINS, Hunterian Oration, 1917, *Lancet*, 1917, i, 217.

FLAIL SHOULDER.

By Major F. F. A. ULRICH, Christchurch, New Zealand.

The extreme rarity of a successful result in the treatment of flail shoulder, and the wonderful mobility and strength in the undermentioned case, are the reasons for publishing these notes.

On Nov. 6, 1918, the patient was struck on the right shoulder by a shell fragment, resulting in a compound comminuted fracture of the head and neck of the right humerus, much destruction of the deltoid muscle and soft tissues, and fracture of the glenoid fossa and spine of the scapula.

Fig 86.—To show the closest approximation of the bones possible before operation.

The following day, at a casualty clearing station, the head and neck of the humerus, and the injured soft tissues, were widely excised. Four months later he was admitted to hospital with the injured limb on an ordinary metal abduction splint. This limb was attached to the trunk by a thick ribbon of tissue, consisting of the outer wall of the axilla with its neurovascular bundle, and some fibres of the coracobrachialis muscle; in fact, all the nerves of the upper limb were intact except the circumflex. The deltoid region was absent, and was replaced by a deep V-shaped scar, in the bottom of which was still some intertriginous sepsis. The limb was flail in every sense of the word.

After the sepsis had been cleared up by lowering the limb into a sling for a few weeks, the limb was replaced on the abduction splint and given vigorous massage, partly to wake up any latent sepsis and partly to loosen the surrounding skin.

Fig. 86 represents the closest approximation of the bones at this stage.

Four months later the operation was undertaken. All scar-sclerosed tissue, including bone, was excised, and the junction between the limb and trunk then looked indeed like a veritable ribbon. The operation was advisedly completed at one sitting, not in two stages as is usual. A tunnel about 2½ inches long was drilled into the region of the glenoid fossa, which could not be recognized as such. A bone-graft about 6 inches long, carrying both medulla and periosteum, was procured from the right tibia ; one end of this was

FIG. 87.—Showing the strong bony union now existing.

drilled to fit into the tunnel in the glenoid. Into this it was hammered, fitting very tightly at an angle of 80° with the trunk, and 25° anterior to the coronal plane of the body.

The limb was now fitted over the graft as it were, the graft pushing its way into the medullary cavity of the humerus, abutting firmly against the glenoid region. Unfortunately, or perhaps fortunately, the graft did not fit quite firmly into the humerus, so with some misgiving a wire was passed through the region of the glenoid and through the outer wall of the humerus without touching the graft. This held the bones quite firmly.

The soft tissues could not be completely approximated, but the skin could ; a hollow resulting, into which a small tube was inserted for twenty-four hours. An abduction plaster was now applied to trunk and limb, and this was kept on, with occasional strength-

enings, for four and a half months. By removing part of the upper wall of the arm plaster a bandage was secured firmly round the flexed elbow and the trunk, thus jamming, as it were, the humerus into the glenoid. The skin healed by first intention, but the tube-hole leaked after nine days, and continued to leak intermittently for three months, when the wire was removed through a small anterior incision, and the sinus healed completely. There is now strong bony union, and at the time of writing, March, 1920, there is remarkable mobility and strength of the limb, notwithstanding that the arm when measured from acromion to external epicondyle is three and a half inches shorter than its fellow (*Fig.* 87). In his book on *The After-treatment of Wounds and Injuries*, Major Elmslie states that, in those cases where the deltoid muscle and head of the humerus are gone, " it is not by any means easy to secure a complete ankylosis of this joint, but it is worth while

FIG. 88.—Showing the amount of voluntary abduction.

FIG. 89.—Further illustration of the extent of voluntary movement.

to make an attempt, if not more than two inches of the humerus have been lost ". After studying this case, where three inches and a half are lost, the advisability of attempting a bony union in all similar cases of much loss of the humerus should be earnestly considered, as an ankylosed short limb is manifestly preferable to a flail shoulder requiring the constant use of an appliance. Seventy degrees abduction is the usual amount recommended, but the extra ten degrees used in this case has probably added to the successful amount of voluntary abduction (*Fig.* 88). The patient can put his hand in his pocket ; the development of the levator anguli scapulæ and the two rhomboids is very marked, and he can already carry his packed portmanteau with the injured limb. *Fig.* 89 speaks for itself.

CONCLUSIONS.

There is little doubt that mere firm approximation of the bones by wire or kangaroo tendon, with or without inclusion of the acromion, would never have gained bony union. The large and tightly-fitting autogenous graft, with the prolonged fixation (four months and a half) in the abduction plaster, is probably the basis of the success in this case. This case was exhibited at the New Zealand Medical Conference in February, 1920.

INSTRUCTIVE MISTAKES.

INFLAMMATION OF MECKEL'S DIVERTICULUM SIMULATING ACUTE APPENDICITIS.

Acute inflammation of Meckel's diverticulum is among the rarer manifestations of the acute abdomen. In the following case, which was sent for operation with the usual diagnosis of acute appendicitis, certain features were present which suggested the true nature of the condition in advance.

A boy of 10 years was admitted to hospital on Jan. 15 last with a history of severe abdominal pain, vomiting, and constipation; his temperature was 99°, pulse 100, and there was referred pain in the umbilical region. Palpation of his appendicular region revealed neither tenderness nor rigidity; while both were so marked in the centre of the abdomen that examination was greatly resented. The anomalous nature of the physical signs was striking. When the boy was anæsthetized, the abdomen was carefully examined, and a small swelling found, apparently in the abdominal wall behind the navel. The possibility of a Meckel's diverticulum being present was considered, and the abdomen was opened immediately to the right of the umbilicus. The swelling which had been previously felt was now seen to be a small tense cyst adherent to the anterior abdominal wall, and joining by a constricted neck a well-marked diverticulum which was identical in size, colour, and consistency with the ileum from which it sprang. It had no mesentery. Both cyst and diverticulum were congested, but there was no evidence of local peritonitis. Clamps were applied, the diverticulum was divided at its junction with the ileum, and the opening in the latter carefully closed by suture at right angles to the long axis of the bowel. The abdominal wound was now carefully packed off, the clamp removed from the diverticulum, and its fæcal contents, including those of the cyst, which were mainly mucoid, were emptied by expression into a sterile swab. There was now some doubt as to how to deal with the dilated umbilical end. To have removed it in one piece with the navel would have necessitated a wide resection of the umbilical region; so it was decided to dissect the cyst off the anterior abdominal wall after division of the peritoneal covering. This was successfully accomplished at the expense of a small hole in the cyst where it was densely adherent. The peritoneal gap was closed by a few catgut sutures. The patient made an uneventful recovery.

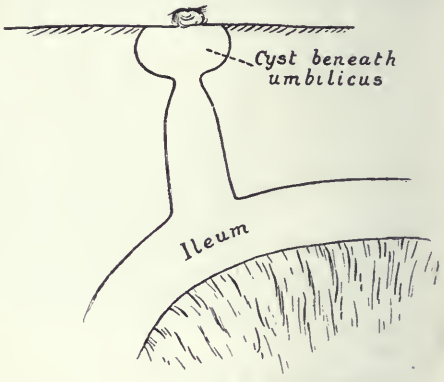

Fig. 90.—Inflammation of Meckel's diverticulum simulating acute appendicitis.

The specimen removed measured 7 cm. in length and was patent throughout.

It is noteworthy that the umbilical cicatrix appeared perfectly normal, and that no history of umbilical troubles in infancy could be elicited.

SHORT NOTES OF RARE OR OBSCURE CASES.

TRANSPOSITION OF VISCERA ASSOCIATED WITH GALL-STONES AND HOUR-GLASS STOMACH.

By R. E. KELLY, Liverpool.

The bibliography of cases of transposition of viscera associated with gall-stones is a short one. H. W. Horn[1] in 1915 stated that, after a fairly exhaustive review of the literature, he was able to find records of only six cases; single examples of this rare combination having been recorded respectively by Carl Beck; Frank Billings; Christian Fenger; Kehr, Liebold, and Neuling; Mayo brothers; and Hupp. Horn himself reports a seventh. I wish to add an eighth, which has, however, in addition to this combination, the further abnormality of an hour-glass stomach.

Sir John Bland-Sutton states that he has encountered the condition of transposition of the viscera only once in 3000 abdominal sections covering a period of twenty years. Kehr states that he has seen it twice in 10,000 autopsies.

Gall-stones are said to be present in 4 per cent of adult males and 20 per cent of adult females. Other authorities give the incidence of gall-stones as 6·94 per cent of the population of the United States and 12 per cent in Germany.

The incidence of peptic ulcer has been variously estimated as 0·74 per cent in Edinburgh, 1·33 per cent in Berlin, and 0·57 per cent among over 165,000 hospital admissions in America. According to Welch, 90 per cent of all peptic ulcers are situated at the pyloric end of the stomach, and would therefore take no part in the formation of an hour-glass stomach.

If these figures are at all accurate, we may take it in round numbers that transposition of the viscera occurs once in about 4000 individuals, gall-stones once in 10 individuals, and hour-glass stomach once in 1000. The chances of any individual possessing all three conditions combined would thus work out as once in 40,000,000. The patient ought, therefore, to be unique in the British Isles.

She is a frail, thin, and pale woman, 40 years of age, married, with two children. She is neither left-handed nor a twin. She has a small scar in the middle line between the pubes and umbilicus, the site of an operation performed eight years ago for abscess said to be due to appendicitis.

Three years ago the present illness was ushered in with a severe attack of abdominal pain. Altogether this attack lasted seven weeks. The pain came on within a quarter of an hour of taking food, usually lasted about twenty minutes to half an hour, and was relieved by vomiting. This pain occurred after every meal, and was so severe that it necessitated the patient staying in bed for two days every week. The pain was always accompanied by extreme restlessness, was colicky in character, and usually felt in the epigastrium, the right costal margin, and the right scapula. It was never on the left side. Following this initial attack she was fairly free from pain until seven months ago, when she had a second attack closely resembling the first. She had another free interval of a month, four months ago, and a third attack and a third interval of three weeks just

before her admission to the Royal Infirmary, Liverpool, on March 23, 1920. All the attacks have been exactly similar to the first, exhibiting the same relation to food, the same site of the pain, and the same relief by vomiting. She persistently denied ever having had the pain under the left costal margin.

During the free intervals she has had occasional pain after food associated with gaseous eructations, but this pain has never been severe nor of the same type as that experienced during her 'bad spells'. She has never had jaundice, hæmatemesis, melæna, putty-coloured stools, or dark urine.

I was asked to see her in order to confirm a diagnosis of gall-stones, but in view of the clear evidence of complete transposition of the viscera and her persistent

FIG. 91.—(*a*) Shows the condition after food and before operation; (*b*) After operation and after a barium meal.
C. Thurstan Holland.

negation of pain on the left-hand side I had her radiographed. *X* rays confirmed the *situs viscerum inversus*, and also revealed the presence of a well-marked hour-glass stomach.

The upper sac was large, and connected with the lower one by a thin stream of the barium meal. There was some delay in emptying the upper sac, but no *x*-ray evidence of any pyloric obstruction. An operation was done on March 31. The median gastric ulcer on the lesser curve was found to be too adherent to the surrounding structures for excision, so I did a posterior gastro-enterostomy, uniting the lowest part of the upper sac to the jejunum. On looking at the left-sided gall-bladder it was found thickened, grey in colour, but with a smooth peritoneal coat. It was full of stones, but no stones could be felt in the common duct. Cholecystectomy was done without opening the gall-bladder,

and the stump of the cystic duct drained with a split rubber tube. Convalescence was uninterrupted.

The only interest in the operation was the feeling of awkwardness in doing a posterior gastro-enterostomy on the wrong side of the abdomen, but I am sure that this was partly due to the difficulty in successfully bringing down the upper sac of the stomach nicely into position. On the other hand, the cholecystectomy appeared to be ridiculously easy, and I wondered at the time whether in difficult excisions of the gall-bladder it might not be advantageous for a surgeon to cross over to the patient's left side. But if he does he ought to be left-handed.

I am indebted to Dr. Thurstan Holland for the radiographs which illustrate this paper.

REFERENCE.

[1] *Ann. of Surg.*, 1915, xlii, 424.

SECTION OF AN ABNORMAL ULNAR NERVE IN THE FOREARM.

By ARNOLD K. HENRY, Dublin.

The presence of a communicating branch in the forearm between the median and ulnar nerves is mentioned as an occasional occurrence.[1] It is rare for these communications to attain to any great size, but their potential importance has recently been emphasized.[2] They appear usually to carry motor fibres from one nerve to the other. In rare cases nearly all the motor fibres of the ulnar reach the lower course of that nerve through the communicating branch from the median, and a lesion of the ulnar nerve proximal to the entry of that branch will then produce ulnar anæsthesia with little or no motor loss. An example of this is quoted by Halipée.[3] The case recorded below is another illustration of the surgical importance of a rare abnormality.

G., a French soldier, was wounded some days previous to admission by a shell fragment which passed through the forearm. The volar wound was a hand's breadth above the wrist, and the dorsal at a slightly higher level. The ulna was chipped, and several small fragments had been removed from the wound, which was suppurating. On June 20, 1918, there was a slight hæmorrhage, apparently from the edge of the posterior wound. This was easily checked. Ten days later there was a sharp hæmorrhage, which was controlled by a bipped tampon. Five days after this, on July 5, the patient suddenly complained of severe pain in the wounded forearm, which was swollen. There was no external hæmorrhage, but a clot bulged from the anterior wound. At operation, the brachial artery was tied in the antecubital fossa. An incision through the deep fascia was made in the middle third of the forearm to expose the ulnar artery, and another in the distal third. Not finding the bleeding point through either incision, the two were united. As this uniting cut was opened up, an oblique strand, which appeared to be fascial, was divided. This strand ran in a distal direction from the middle line of the forearm towards its ulnar border. Inspection of the cut surfaces showed by the bulging of fasciculi that the divided strand was a nerve. Its diameter was about two-thirds that of the normal ulnar. As it emerged from the plane between the superficial and deep flexors of the fingers in the middle third of the forearm, it ran parallel to the oblique upper part of the ulnar artery. It then crossed the junction of the middle and lower thirds of the artery, which lay deep to it (*Fig.* 92). The cut nerve was immediately sutured. The source of the hæmorrhage was found at the origin of a muscular branch springing from the ulnar artery, and the wound, which was bipped and sutured in layers, healed by first intention. Paralysis and wasting of the hand muscles which are ordinarily affected by a complete lesion of the ulnar nerve, followed the operation. There was also a sensory loss of the usual ulnar type, which is interesting, since the communicating branch generally carries motor fibres only.

In this connection a summary of the occurrence and varieties of communicating branches found in 406 forearms is worth quoting. Communicating branches occurred in 15 per cent of the forearms examined.[4] Their size varied from that of fine thread to small whipcord, and their length from 3 to 9 cm. Four varieties of junction are noted :—

1. The communication may connect the median with the ulnar nerve in the upper third of the forearm.

2. The anterior interosseous branch of the median may be connected in the same way.

3. The communication may occur as a loop between muscular twigs to the flexor profundus from the median and ulnar respectively. In this group Fagan observes that the median directly supplies the flexor profundus of the index, and the ulnar that of the little finger, while the connecting loop innervates the deep flexors of the ring and middle fingers.

4. Very occasionally a superficial branch may arise from the median nerve near the elbow, and go to join the ulnar, or its palmar cutaneous branch, in the lower third of the

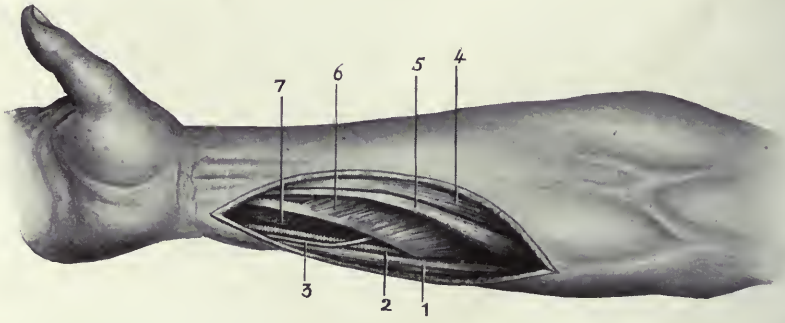

FIG. 92.—Section of an abnormal ulnar nerve. Showing (1) Flexor carpi ulnaris; (2) Ulnar artery; (3) Ulnar nerve; (4) Flexor carpi radialis; (5) Palmaris longus; (6) Flexor digitorum sublimis; (7) Flexor digitorum profundus.

forearm. Since the junction in the last instance is with a purely cutaneous nerve, the communication possibly carries sensory fibres.

Thus, anatomical evidence indicates that the communicating branch may carry either motor or sensory fibres, and section of the nerve in my case seems to demonstrate that it may carry both.

As no other nerve was seen corresponding to the normal ulnar, it would appear that, just as fibres of the lesser internal cutaneous may reach their brachial distribution by way of the intercosto-humeral, so, in the case I have reported, the main stream of ulnar fibres followed the course of the median nerve, and eventually regained their usual path through a tributary channel of unusual size.

The condition, in fact, suggested the presence of a medio-ulnar nerve dividing into median and ulnar branches, and closely simulating its homologue in the lower extremity, the posterior tibial nerve and its plantar divisions.

I wish to thank Mr. R. Atkinson Stoney for confirming my anatomical findings at the operation, and Professor A. F. Dixon for his assistance with the literature of the subject.

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[2] PURVES STEWART, *Nerve Injuries and their Treatment*, 2nd ed., 159.
[3] HALIPRÉE, *Revue Neurol.*, 1917, 233.
[4] *Jour. Anat. and Physiol.*, xxvii, 192.

A SLOUGHING FIBROID OF UTERUS WHICH RUPTURED THROUGH THE FUNDUS INTO THE PERITONEAL CAVITY, CAUSING GENERAL PERITONITIS. LAPAROTOMY—COMPLETE HYSTERECTOMY.

By HAMILTON DRUMMOND, Newcastle-on-Tyne.

This case appears worthy of record, as it illustrates an extremely rare complication of a uterine fibroid.

Fig. 93.—To show the uterus, the size of a large orange, with its appendages. In the fundus of the uterus is a rounded perforation through which a gangrenous portion of the fibroid pointed; the adherent omentum at this point has been removed.

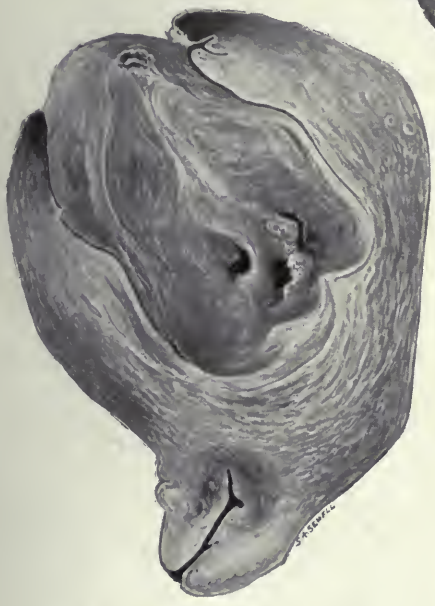

Fig. 94.—Shows the uterus bisected. The hole in the fundus has been very much enlarged, as it was thought at the operation that the septic contents could be removed by this route. This, however, proved impossible, as the fibroid, interstitial in type, was firmly fixed towards the lower aspect of the uterus.

E. S., age 36, a spare anæmic woman, was admitted to the Royal Victoria Infirmary on Oct. 15, 1919, with the following history:—

She was sitting quietly at home seven hours before admission to hospital, when she was seized with very severe abdominal pain—first in the stomach, and later all over the bowels. She vomited shortly afterwards, and was obliged to go to bed immediately.

On admission she looked extremely ill. Temperature 101·5°, pulse 120, and respirations shallow and rapid. The abdomen moved scarcely at all; she was tender all over, and rigidity was well marked. The point of maximum tenderness was present in the whole of the lower abdomen. Vaginal examination revealed a normal cervix with acute tenderness in fornices.

Her previous history showed that she had been married ten years ; one child nine years ago, healthy ; and a miscarriage eight years ago. For the last two years she has suffered from menorrhagia, blood coming away every fortnight, often in large quantities and in clots. She was thought to have a leaking pyosalpynx, but the sudden onset of her pain suggested rupture of some other viscus.

Operation eight hours after her sudden attack. Open ether. Mid-line incision below umbilicus. The peritoneal cavity was found to contain a large amount of free turbid fluid not unlike that seen in ruptured gastric ulcer. About two pints were mopped out of the lower abdomen. The omentum was found to be adherent to the fundus of the uterus ; on separating the adhesions, a hole the size of a lead-pencil bore was seen entering the uterine cavity. On enlarging the hole in the uterus a very offensive smell was noticed, with escape of thick pus, and the upper surface of a sloughing fibroid was seen, and felt with the finger. The tumour was very firmly fixed in the cavity of the uterus.

The most rational treatment appeared to be the removal of the focus. The uterus was removed by supravaginal hysterectomy, including the cervix and both tubes and ovaries. A drain of gauze was inserted into the vagina for five days, and the abdominal wound was drained by a rubber tube for forty-eight hours.

Recovery was straightforward, and she returned home three weeks after operation.

DIVISION OF POSTERIOR SPINAL ROOTS FOR THE RELIEF OF PAIN DUE TO COMPLETE DISRUPTION OF THE BRACHIAL PLEXUS.

By Sir H. GILBERT BARLING, Birmingham.

The patient, an officer, was wounded early in 1915, the injuries sustained being severe compound fracture of the right clavicle, with division of the subclavian vessels, complete disruption of the brachial plexus, and injury to the upper part of the right thorax involving the lung. He passed through a perilous time, and it was owing to the skilful care of Mr. Kempe, of Salisbury, that his life was saved.

I did not see the patient until April, 1916, when I found the following conditions. The right arm was enormously swollen, and of course quite helpless and anæsthetic. The wound was healed, except that there was a bronchial sinus opening to the upper part of the right lung.

For about a year the patient had suffered intolerable pain referred to the distribution of the brachial plexus, pain which made life an absolute burden, and for which increasing doses of morphia had been required, although the patient, knowing the drawbacks of the remedy, had done his best to do with as little morphia as possible.

His condition when I saw him was pitiable, and he was an absolute wreck physically. I came to the conclusion that cicatrization of the wound with involvement of the proximal end of the divided nerves was responsible for the pain, and that, owing to the tremendous extent of the cicatrization at the root of the neck, it was little likely that successful operation locally, for freeing and shortening the divided nerves, could be performed. I therefore advised intrathecal division of the posterior roots of the brachial plexus on the right side, though one could not but feel that the operation was accompanied by considerable risk from shock and from possible infection, owing to the existing bronchial sinus not far from the incision. If the operation was successfully accomplished, it was arranged that amputation of the disabled limb should follow when the patient was fit to bear it.

The operation was performed on April 11, 1916, with the assistance of Mr. Kempe. A little adrenalin was injected into the tissues first of all.

It is not necessary to enter into the details of the operation, except to say that no attempt was made to deal with the roots through a hemilateral laminectomy, nor through the unopened theca. A partial resection of laminæ does not give sufficient room to work

free from embarrassment, and extrathecal division appears to me to run the risk of incompleteness owing to the difficulty of identifying the roots if there were much oozing of blood, as often happens. The roots divided were the 5th, 6th, 7th, and 8th cervical, and 1st and 2nd dorsal. The dura was carefully closed with continuous chromicized catgut suture; the muscles were also carefully sutured with chromicized gut, supported by a few deep sutures of silkworm gut; the skin was closed separately. I heard from Dr. Kempe during the patient's convalescence, which gave no cause for anxiety, though it was a battle to discontinue the morphia, a battle in which the patient played a very good part. The patient was allowed to get up on April 29, when his neck movements were becoming free, and his only rather troublesome condition was a sensation of itching in the right index finger. Mr. Kempe amputated the arm at the shoulder-joint subsequently, and a good recovery followed.

The real interest of the case, I feel, lies in the subsequent history, as showing the permanence of the relief given. A letter received from the patient in July, 1919, says: "I have been doing duty for two years now, and am at present commanding the depôt of my regiment. I still feel the arm, but the pain is bearable. The wound in my neck is still open. I can do nearly everything with my left hand, and fly fish with some success."

REVIEWS AND NOTICES OF BOOKS.

A Manual of War Surgery. By Colonel Seymour Barling, A.M.S., and Major John T. Morrison, O.B.E., R.A.M.C. (T.). Large 8vo. Pp. xvi. + 479. Illustrated. 1919. London: Henry Frowde, Hodder & Stoughton. 21s. net.

This manual is an authoritative exposition of the work done at a base hospital abroad, which will be useful as a starting-point should it ever be necessary to reopen one. It records, in a series of short but able and well-written articles, what can and cannot be done in such a hospital. The articles are contributed by those who have had extensive experience in the subjects upon which they write, and in every instance they are of a most practical character. The book is well illustrated, and there is a satisfactory index. It is a good guide to the modern treatment of wounds generally, as well as to those which are peculiar to war as we have recently seen it.

An Atlas of the Primary and Cutaneous Lesions of Acquired Syphilis in the Male. By Major C. F. White, M.B., and W. H. Brown, M.D. With Foreword by Lieut.-General Sir T. H. Goodwin, K.C.B. Large quarto. Illustrated. Pp. 32 + ix. 1920. London: Bale, Sons & Danielsson. 27s. 6d. net.

This atlas is based on careful records of some 19,000 cases of syphilis treated in a large military hospital during the War. All cases of interest were photographed, and from the immense store of photographic material thus obtained the authors have prepared their atlas.

The problem of venereal disease, as Lieut.-General Goodwin, A.M.S., points out in his foreword, is one of the urgent questions of the moment. The menace that it constitutes to the national health can only be diminished by early diagnosis and efficient treatment. For this reason any work that may be of service in assisting the practitioner to gain an accurate knowledge of the earlier manifestations of syphilis is very welcome. The atlas deals almost entirely with early lesions, and the question of diagnosis is gone into very fully. Only that amount of letterpress is included which is necessary to direct attention to the significant characteristics of the lesions portrayed in the photographic or coloured plates. Lengthy and tedious descriptions of skin lesions have been avoided, for the text is entirely subsidiary to the illustrations. In order that the reader may obtain a still more accurate impression of some of the primary lesions of syphilis, stereoscopic views of the latter are included. These can be studied by means of a hand stereoscope.

Some interesting points are brought out in the analysis of the 19,000 cases made by the authors. One of these is confirmation of the frequency with which multiple hard chancres are encountered (19 per cent of cases)—a fact that all modern statistics have borne out. In one case as many as 49 primary chancres were encountered—surely a record in this direction.

The final chapter deals with some common cutaneous lesions not infrequently mistaken for syphilis, a section that should be of service to those who have only a nodding acquaintance with the subject of skin diseases. Included in the plates illustrating this chapter is a photograph of a case of gonorrhœal keratosis affecting the penis: a rare and interesting condition.

Altogether this atlas will form an extremely useful addition to the library of the medical student and of the qualified practitioner alike. That it is expensive is no surprise when such factors as the number of plates it contains and the modern cost of reproduction are borne in mind. We congratulate the authors on the fruits of their thorough and extensive observations. The atlas has the stamp of thoroughness and accuracy.

Backwaters of Lethe; some Anæsthetic Notions. By G. A. H. Barton, M.D. Pp. 151 + vii. Illustrated. 1920. London: H. K. Lewis & Co. 5s. net.

This little book deals with the many difficulties which beset the anæsthetist during the performance of his work. It is chiefly valuable as being the direct outcome of a prolonged experience of this type of work. Viewed from this standpoint it is of great assistance, especially to the man who is taking up the administration of anæsthetics as a speciality, but whose experience is yet small.

Any book on such a subject must of necessity have its value when it is the outcome of personal practical experience, and, if the reader does not entirely agree with the author on every point, this does not lessen the value of the work. Such debated questions as the choice of alkaloids for pre-anæsthetic medication will always provoke controversy and produce divergent opinions, but Dr. Barton's arguments are clearly put, and will certainly be of use to the man whose experience is still limited, even if he finally feels inclined to differ.

There is a welcome absence of description of obsolete instruments. If we may criticize one point, it is the title of the book, which perhaps does not encourage the reader at the outset, and indeed rather belies the excellence of its contents.

THOMAS GALE.

1507–1587.

Very little is known of Thomas Gale, one of the great surgical teachers of the sixteenth century. He was born in London in 1507, and was apprenticed to Richard Ferris, afterwards Serjeant Surgeon to Queen Elizabeth. He practised for a time in London, and served with the army at Muttrell in 1544, and at the siege of St. Quentin in 1557. He then settled again as a London surgeon, and became Master of the Company of Barber Surgeons in 1561.

Machyn, in his *Diary*, tells of a great day during his mastership when his side won at an archery meeting at Moorfields. "The xx day of June (1562) there was a great shooting of the Company of Barber Surgeons for a great supper at their own Hall for a xxx mess of meat—and they had six drums playing and a flute and two great ancients (flags) and as a shot was won down went that and up the other and Master Gale and his side won the supper."

But if little is known of his life, his writings are a pure joy to read. Who at the present day would begin a surgical treatise in this way?—

"Phœbus, who chaseth away the dark and uncomfortable night, casting his golden beams on my face, would not suffer me any longer sleep, but said, 'Awake for shame and behold the handywork of our sister Flora, how she hath revested the earth with the most beautiful colours, marvellously set in trees, plants, herbs, and flowers; insomuch that the old and withered coat of winter is quite done away and put out of remembrance; at which words of Phœbus my heart quickened in me and all desire of sleep was eftsoons forgotten. Wherefore I am now come into this beautiful meadow to recreate myself and gather some of those pleasant herbs and flowers which here do grow. But let me see, methink I see two men walking together and reasoning also very earnestly. I will approach nearer unto them, perchance they be of my acquaintance. Surely I should know them. I am deceived if the one be not my friend Master Gale and the other Master Field. It is so indeed, wherefore I will go and salute them. God that hath brought us together into this place, make this day prosperous and fortunate unto you both.

"Tho. Gale.—'Brother Yates, the same we wish unto you, and you are welcome into our company.'

"John Field.—'This fair and pleasant morning will not suffer Master Yates to keep his bed, but leaving the city he roameth the fields to espy out some strange herbs unto him yet unknown.'

"John Yates.—'I must of force confess that you hit the nail on the head, but since my hap is so fortunate as to meet with you both and that now in this pleasant morning I would leave off my former determined purpose and would require you to enter into some talk of Chirurgery. For since you both were brought up under Master Ferris (being now Serjeant Chirurgion unto the Queenes Majestie), one at whom, both for his knowledge and experience, you did not a little profit, and also that you have had long practice yourselves, you should marvellously pleasure me and profit other, for so may it come to pass, that it might be in the place of an Institution unto those that shall hereafter desire the knowledge of Chirurgery.'"

Surgery is then discussed by question and answer, and Gale shows that a surgeon needs as instruments "incision shears, an incision knife, a fleam, a lancet, a cauterising

iron, a pair of pincers or nippers to take off plaisters, a probe to search the wound with, a crooked hook, a needle, and a quill to sew and stitch with." He may also have a trepan, a speculum oris, a speculum matricis, a syringe masculine and also feminine. "In my judgment," says Gale, "a Trepan is most necessary and of an excellent invention in hurts of the head. For without it where the cranium is fractured, bruised, or else of the inward panicles depressed, you shall little prevail. I myself have used it with great profit divers times and especially once in Cambridgshire anno 1559. A servant of Master Wroth's riding in the fields and leading a young horse in a halter, tied fast about the arm of the servant, the horse being wild and not broken, starting aside, unhorsed the man and drew him by the arm about a great field so long that what with striking, what with drawing, haling and pulling being wearied, he stood still until company came and unloosed the halter and took up the man half dead and removed him unto his master's house. Chirurgions were sent for, who finding the servant speechless and without remembrance of any one whom he saw, they not perceiving the cause thereof themselves, neither yet could be shewed of the patient the place affected, departed and left him uncurable. Master Wroth sent for me, and I, seeing him speechless and without remembrance, conjectured the hinder part of the head to be hurt and smitten of the horse, which I was more certain of when feeling that part I found it soft. Wherefore I, taking off the hair, did first make incision and after that set a Trepan on his head and bored the Cranium through and took out the piece of bone, which done, there issued much blood, black in colour and drawing to putrefaction, out of the contused and broken veins. The next day following the servant spoke and came again to his perfect remembrance, and I, using things in this cure as art required, God restored the man in my hands to his perfect health. I could also show you other examples where the like chances have happened and the Chirurgions either not knowing or wilfully neglecting this profitable instrument have brought the patients to their last end, so happened it to a servant of Maister Paget's in Philpot lane in 1538."

Following the *Institution of a Surgeon*, and like it, issuing from "my house in London" the second of August, 1563, are the four books of *The Enchiridion of Chirurgerie*, addressed by Gale "unto the young men of his Companie, studients in the noble art of Chirurgerie". The book, he says, was written for four special reasons, because previous textbooks "were writ in a tongue which the most of you understand not or the authors use corrupt and barbarous names of sickness and medicines or they be too tedious and long or else too concise and briefe."

The teaching of the *Enchiridion* is sound; thus in cases of gangrene: "If the leg chance to come to such corruption beneath the knee, that of necessity you are constrained to take it off from the other part, it is best to cut it off one good hand's breadth beneath the knee. So shall the party have a resting place for a stilt to go upon. And although it needeth no more but to take his foot off only, yet forasmuch as the rest of his leg should be but a trouble unto him, it is better to take it off under the knee, as I have said before, for the pain will be all one and the danger is least in that place. And further you must take diligent heed that you make your incision above the corrupted parts, for else the flesh or bones being corrupted above the place whereat you make your incision might cause you to have a new work to the great grief and pain of the patient as I have seen oftentimes. And therefore if the corruption have taken the joint of the knee, so that it cannot be cured, but that of force the member must be amputated and cut off, then take it off three fingers breadth above the knee, or in any wise take it not off in the juncture of the knee for that is very dangerous and contrary to the opinions of all the ancient writers. And that order you observe in taking off the leg, the same shall you follow in taking off the arm. But before you begin this work you ought well to consider with yourself and also to call other expert men to you to see the patient, conferring with them whether there be any way to keep on the member and to cure it by any way possible, for it is great slaunder to the art of Chirurgerie and also matter in conscience to take away any member which otherwise might by art be cured, although it be both painful and long or it be done."

Thomas Gale,

THOMAS GALE

Reproduced from the octavo edition of his works published in 1563.

Gale, therefore, had settled in his own mind that a gangrenous limb should be amputated well above the affected part and not through it. But the question remained unsettled for many generations to come in spite of his teaching. The expression "matter in conscience" is unusual, and is perhaps evidence that the writer had not given up the old faith in which he must have been educated.

Gale's real claim to remembrance rests on his *Treatise of Gunshot Wounds* published in 1586, where he starts with "The Proposition or Thema that the usual Gun-powder is not venomous, neither the shot of such hotness as is able to warm the flesh and produce an eschar". The theory that bullet wounds were poisonous was held by all writers on surgery, but Gale disproved it after a painstaking enquiry, and gives sound advice as to the treatment of gunshot wounds.

"If so be that you cannot without great pain and much searching find the shot, it is much better to let it remain within, than with provoking of mortal accidents labour the taking of it out. For there is no danger in letting the shot remain in and there is great peril in long searching. I myself, serving at Muttrell under the mighty and puissant Prince Henry the eighth about the year of Christ's incarnation 1544, had the experience of eleven sundry soldiers shot into the body, without piercing of any inward member, and I could not get out the shot without great difficulty and making incision, and therefore I, letting the shot remain within the body, did perfectly cure the patients and they lived long after without any grief or pain provoked by the shot.

"In like manner about the year of Christ 1557 whenas Philip King of Spain besieged St. Quintaines, I then serving under him had divers soldiers in cure wounded in like sort as is rehearsed and the shot still remaining in the body, they were (thanked be God) restored to health. I do also now call to remembrance that there came a soldier to London, when I first practised the art of Chirurgery, who was shot in the belly at the siege of Pavia and made perfectly whole, the pellet remaining within. This soldier twelve years after he was thus cured coming to the City had a great Apostume in the flank. I then among others being then called to the cure we applied such medicines to the Apostume, as we accustomably do to Apostumes named Bubones, engendered in that part. And when the apostume brake and came to suppuration we took out a pellet of lead and after did cure the ulcer and make the man whole. These I do bring only for example's sake that other Chirurgions being in the wars should not too much busy themselves or put the patient to pains or in danger in taking out the shot."

In 1566 Gale published a second volume of surgical works, mostly translations with a running commentary. The most important is his treatise *On the Office of a Surgeon*, which is a scathing indictment of the condition of contemporary surgery. It is prefaced with a little copy of verses which begins :—

"Go forth my painefull booke
Thou art no longer mine
Eache man may on thee looke,
The shame or praise is thine.

"Thou mightest with me remaine
And so eschew all blame,
But since thou art so fayne
Go forth in God's name."

After drawing attention to the wiles of unlicensed practitioners of surgery, he says : "I will not speake further of a multitude of strangers, as pouch makers and pedlers, with glass makers and coblers, which run out of their own countries and here become noble physicians and Chirurgions, such as now is most in estimation and ruleth all the roast in our country so that the poor English men and such as have served in the time of wars with expenses of their goods and loss of their lives, yea and the rest of them that be living must of necessity serve at all times both by land and sea, as well in the time of wars as in the

time of pestilence. These poor men, I say, are constrained to serve to their utter undoing, and when they come home again, they, their wives and their children, may go pick mussels, for this jolly company afore spoken of, have taken up all their acquaintance whilst they were serving in the wars."

It is clear, therefore, that war produced the same professional results in the sixteenth as in the twentieth century, and that we have made no material moral progress in the interval.

The portrait of Thomas Gale is prefixed to the octavo edition of his works published in 1563. It represents him as a surgeon wearing the cap and ring of a Master of Surgery and the gown of a Barber Surgeon. The portrait is not identical with that of John Halle which was reproduced in the BRITISH JOURNAL OF SURGERY, vol. V, p. 182, though it closely resembles it in many respects. It is probably therefore a real portrait by the same engraver. It does not appear in either of the volumes of the 1586 edition, which are small quartos published by Thomas East.

CYSTS, AND PRIMARY CANCER IN CYSTS, OF THE BREAST.

By Sir G. LENTHAL CHEATLE, London.

The ideas contained in this paper are based upon observations made from 'whole sections' of female breasts. Should any success be attained by these observations it will depend entirely upon the fact that they were made upon the study of whole sections. Small sections cut from small portions of diseased breasts are of no value except that their perusal can establish a diagnosis of cancer; but generally, small sections can throw little light upon the origin of cysts and primary cancer in cysts of the breast.

I believe the proposals to which I refer are a true conception of the state of affairs. But the failure to convince surgeons on one point does not exclude the possibility of success in securing their conviction on the remaining points.

But I hope I shall not fail to convince the reader that cancer can and does begin in cysts, and further, that not only can it begin therein, but it also gives rise to such definite and typical microscopical appearances that this source of origin can be thereby demonstrated.

This article is divided into two parts: (I) Cysts in the breasts; and (II) Cancer of cysts in the breasts.

I.—There are two types of cyst, *A* and *B*. The difference exists in the character of the epithelium which lines their cavities and intracystic growths. Intracystic, simple, papillomatous growths are common in both types, and their presence is, in the absence of clinical signs, most frequently quite unsuspected. In both types the cysts are multiple. I may say here that I have never seen a breast which contained a single cyst. Both types usually co-exist in the same breast, and both types make their appearance in the breasts that are apparently normal, and others that are obviously abnormal, of women about middle age.

A. This type of cyst is duct in origin, and cystic breasts mainly of this type contain many dilated ducts which give rise to the cystic condition and cystic appearance on section. *Figs.* 95, 96, and 97 are whole sections of cystic breasts belonging mainly to this type. The cysts are lined by duct epithelium, and at the periphery of the breast the cysts branch and terminate in the acini of the glands, and the acini are not necessarily dilated (*Figs.* 95A *and* 96A). In the description of *Fig.* 95, I indicate the presence of an intracystic papillomatous growth. I may say here that its epithelium is very prolific, and that therefore its nature is very suspicious and possibly malignant. The size of the cysts diminishes in calibre as they reach their end. Perhaps *Fig.* 97A shows my point more convincingly. A is a duct which happens to be cut longitudinally at its bifurcation, and with the exception of a single interruption in each of the resulting branches (due to part of the fibrous tissue making its appearance as a result of a slight deviation in the courses of the branches) they terminate in branches of diminishing sizes in acini. The ducts become tortuous and almost varicose, and hence give rise, on microscopical examination, to the false appearance of many cysts, when really they are in direct continuity and form part of one tortuous dilated duct. All ducts are not affected.

The cysts appear to stop (or begin) at the part where the musculature of the nipple reaches its lowest distribution (*Fig.* 103A). This breast, although reproduced to illustrate the type of cancer to which I am about to refer, also shows the cysts beginning with almost

dramatic suddenness below the musculature of the nipple. The ducts in the nipple do not exhibit the marked dilatation seen in continuation below. As a rule, only occasionally and in advanced disease do they show cystic change. Hence there seems to be a possible

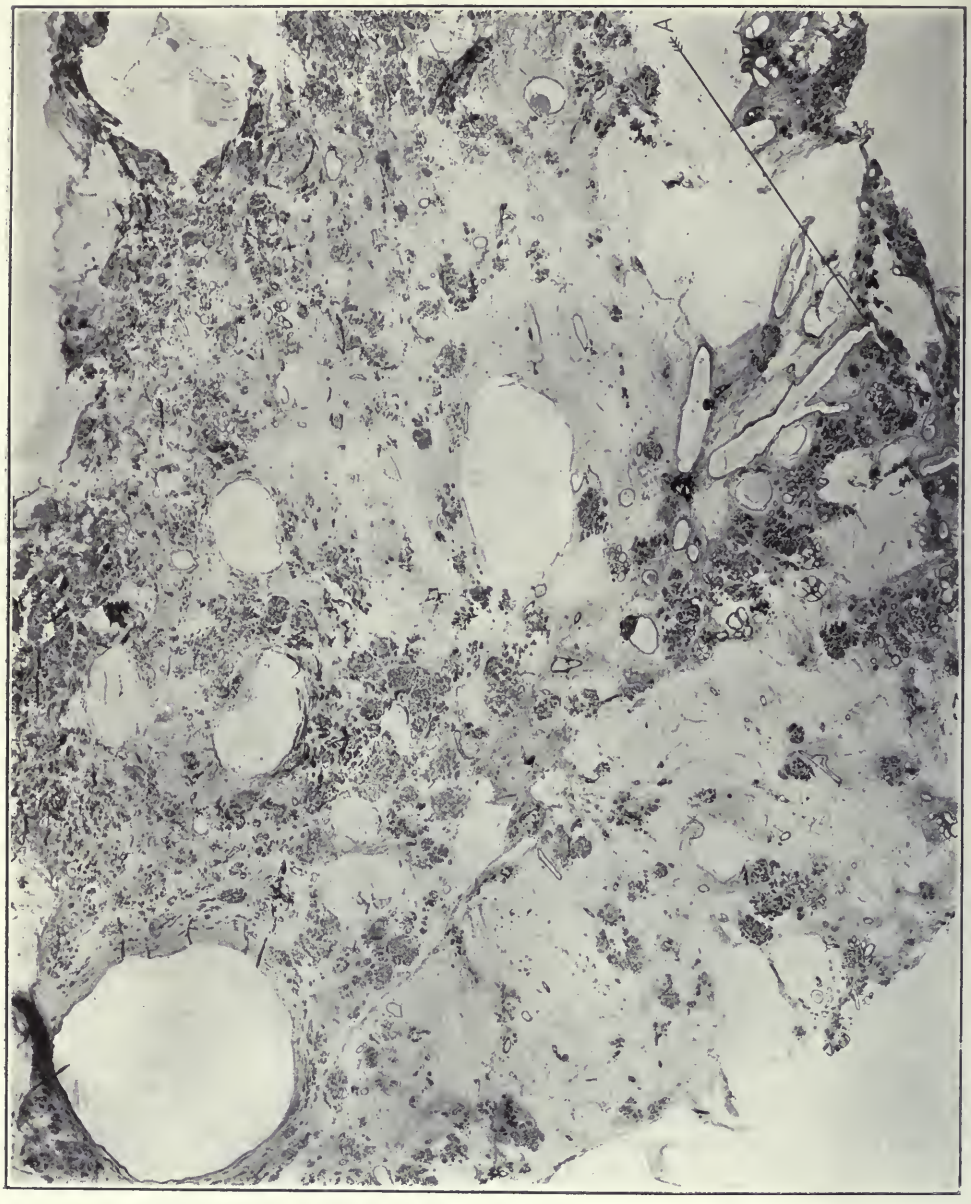

FIG. 95.—Part of whole section of cystic breast, showing cysts and their termination in undilated acini at A, and a little higher in same duct, just above duct A and at an angle of 45 degrees to it, is a branch, into the interior of which can be seen projecting a small intracystic, papillomatous growth.

difference in behaviour between those parts of a duct in the nipple and those parts which are situated in the breast below the musculature of the nipple. I do not offer any explanation of this fact ; but it suggests, what I do not believe to be altogether true, that some mechanical reason may intervene at this part and cause dilatation of the distal parts of

the duct. I do not believe that cysts of the breast are mainly due to mechanical obstruction. The appearance of the epithelium in these cysts seems to indicate that its proliferation is causing the cyst rather than the reverse. Further, I have examined whole sections of a small breast cut in serial sections, the nipple of which was the site of Paget's disease of the nipple. Although all ducts in their passage through the nipple were

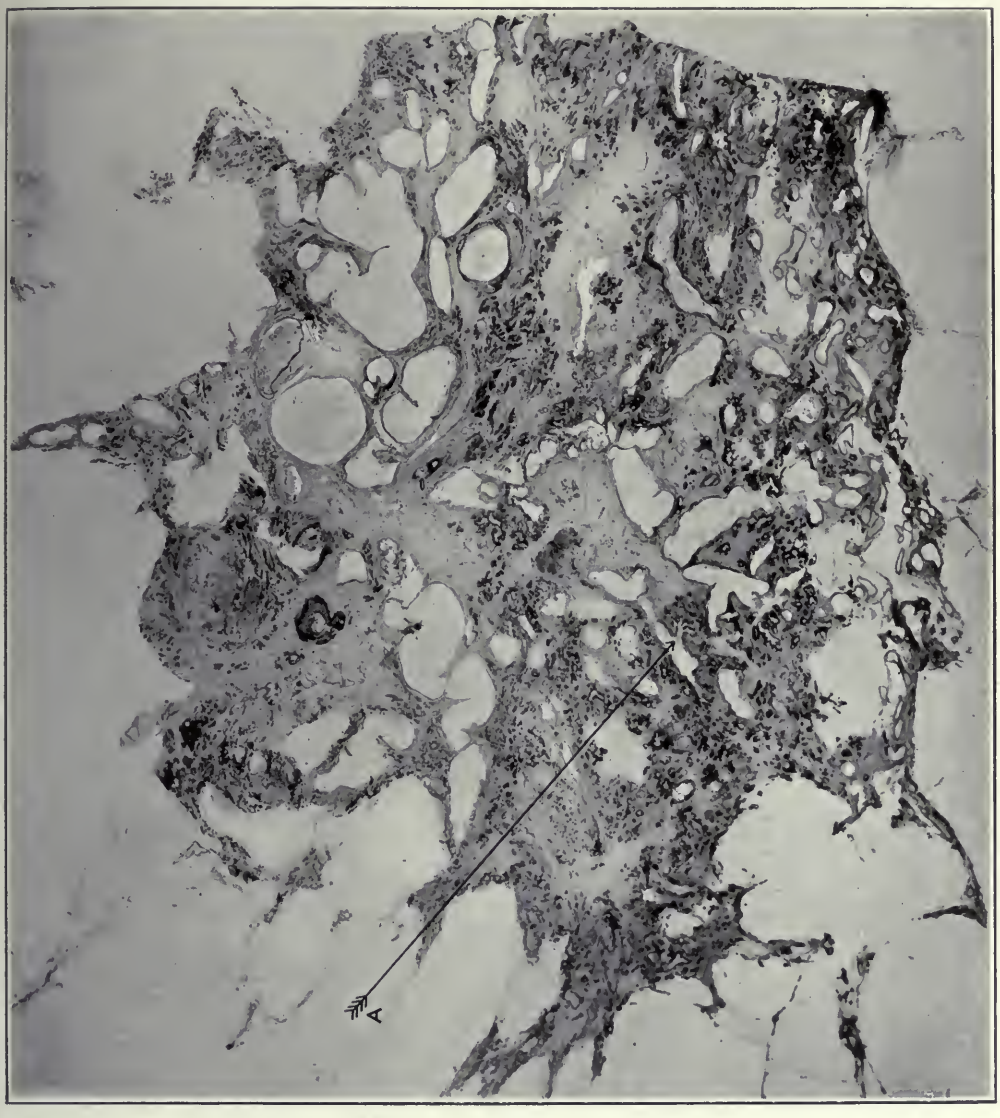

FIG. 96.—Part of whole section of cystic breast, showing cysts and their termination in undilated acini A.

obstructed, there was no dilatation of the ducts below the nipple except those which contained new growth. It is the definite papillomatous formations in cystic ducts that lead me to assume that the proliferation of epithelium is the important factor in cystic formation and that cysts form to accommodate the epithelium. On the other hand, it is quite clear that intracystic growth may intervene quite independently of the cause of cystic development.

B. The cyst seen in *Fig.* 111 is a good representation of this type; its wall and the surfaces of its intracystic papillomatous growths are lined by columnar epithelium, beautiful in appearance, with feathery well-defined cells. My reason for describing it under a different heading from the other cysts is that there is some doubt from which previously existing epithelium-containing structure they arise.

FIG. 97. Part of whole section of cystic breast, showing cysts and their termination. At A a duct is bifurcating and happens to be cut so that the resulting branches are shown to their termination in undilated acini.

Some observers state that they arise in acini, and that before the acini become cystic the cells lining them become feathery, and elongated and columnar. I have very carefully studied this statement, and I have many sections of different breasts which make it impossible to say that it is untrue. On the contrary, in these sections there are changes that can only be interpreted by saying that the epithelium of acini became columnar prior

to the cyst formation therein, and it appears that the epithelial activity had a great deal to do with the cause of cyst development. Further, I have two sections from separate breasts which show a duct lined by its typical columnar epithelium terminating abruptly in a microscopical cyst lined by the feathery epithelium just described, and which appears

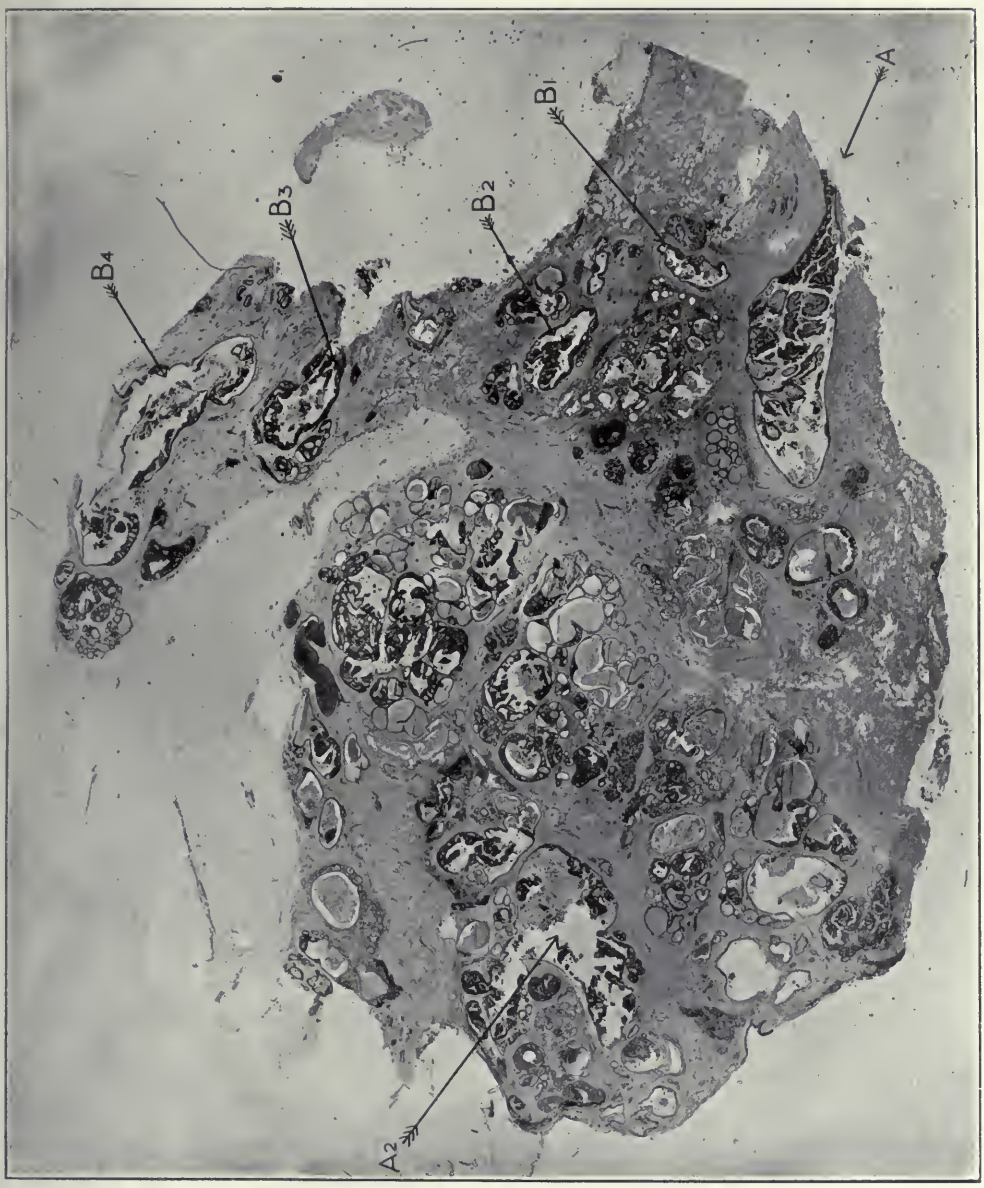

FIG. 98.—Part of whole section of same breast as in *Fig.* 99. It shows the cysts becoming filled with epithelial proliferation; the epithelium grouping itself within the cysts in curious formation of lacework, and resembling in parts the spokes of a wheel. In some there is intracystic growth of more definite nature. In no part of this breast was there any indication of epithelial elements in fibrous tissue or fat outside the cysts. Certain cysts can be seen coalescing.

to be an acinus. But, on the other hand, I am just as convinced that in the epithelium-lined ducts (and there can be no doubt they are ducts) can be seen the same type of feathery cells, and I have sections which prove it.

The presence in the cyst of this particular columnar feathery cell cannot alone

determine the source of the cyst. Therefore I cannot say in what structure the cyst in *Fig.* 112 arose. Many observers of the greatest repute tell me they are sure it arose from a duct. I am very doubtful if it can be anything else than an acinus.

II. I now desire to show that within cysts, whatever be their origin, cancer can begin. Cysts situated at the extreme periphery of breasts often become the site of cancer; and the only cysts that show very marked epithelial activity in breasts removed for cystic disease only are often situated at the periphery.

For the sake of my argument the tumour shown in *Fig.* 98 is very important. It shows the state of affairs, to which I draw attention, in an early part of the process. *Fig.* 99 is a reproduction under higher power of the same section, and shows simple cysts and others which are gradually being filled with great epithelial proliferation. In no part of this breast can be found any sign of epithelium spreading in the fat or fibrous

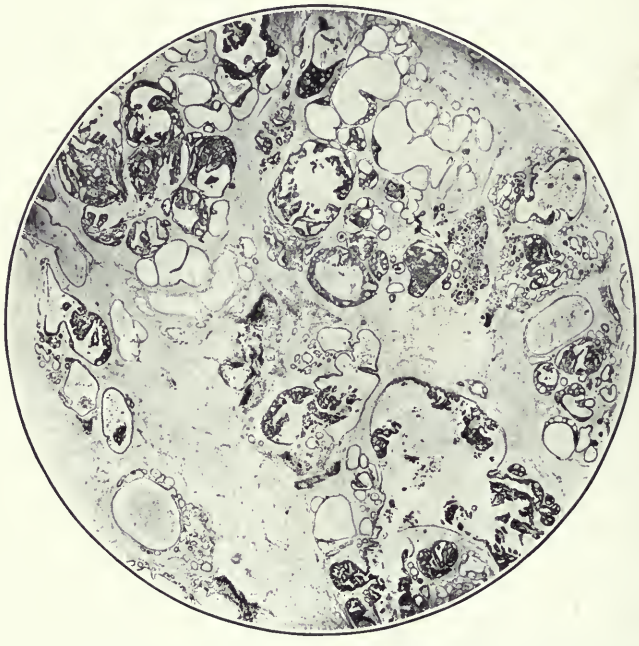

FIG. 99.—A photograph made with a higher power from part of *Fig.* 98, showing the curious lacework formation of epithelium within the cysts. In parts the spaces in the meshwork of epithelium are seen occupied by delicate fibrous tissue, in others by degenerated epithelial cells, and in others by degenerated fibrous tissue. There are a few small collections of lymphocytes here and there, but no epithelial elements can be distinguished outside the cysts in this particular breast.

tissue of the gland. The epithelial activity is limited, so far as I could determine, to the inside of the cysts. There are definite indications that contiguous cysts have become, and are becoming, confluent. Implication of axillary lymphatic glands was absent. I would like to have been able to show that A and A^2 in *Fig.* 98 are parts of the same duct, and that B^1, B^2, B^3, and B^4 are parts of another duct or are branches of the same duct as A and A^2. In serial sections made from the tumour of *Fig.* 103, I can show that exactly the same appearance can be explained in this way, and that the cancer must be diffused about the breast a great deal through this cause.

Fig. 100 is a photograph of another breast, in which the same type of disease is present but in a more advanced condition, and the epithelial cells can be seen invading extensively the fibrous tissue of the gland in its central parts, and the adipose tissue in its peripheral parts.

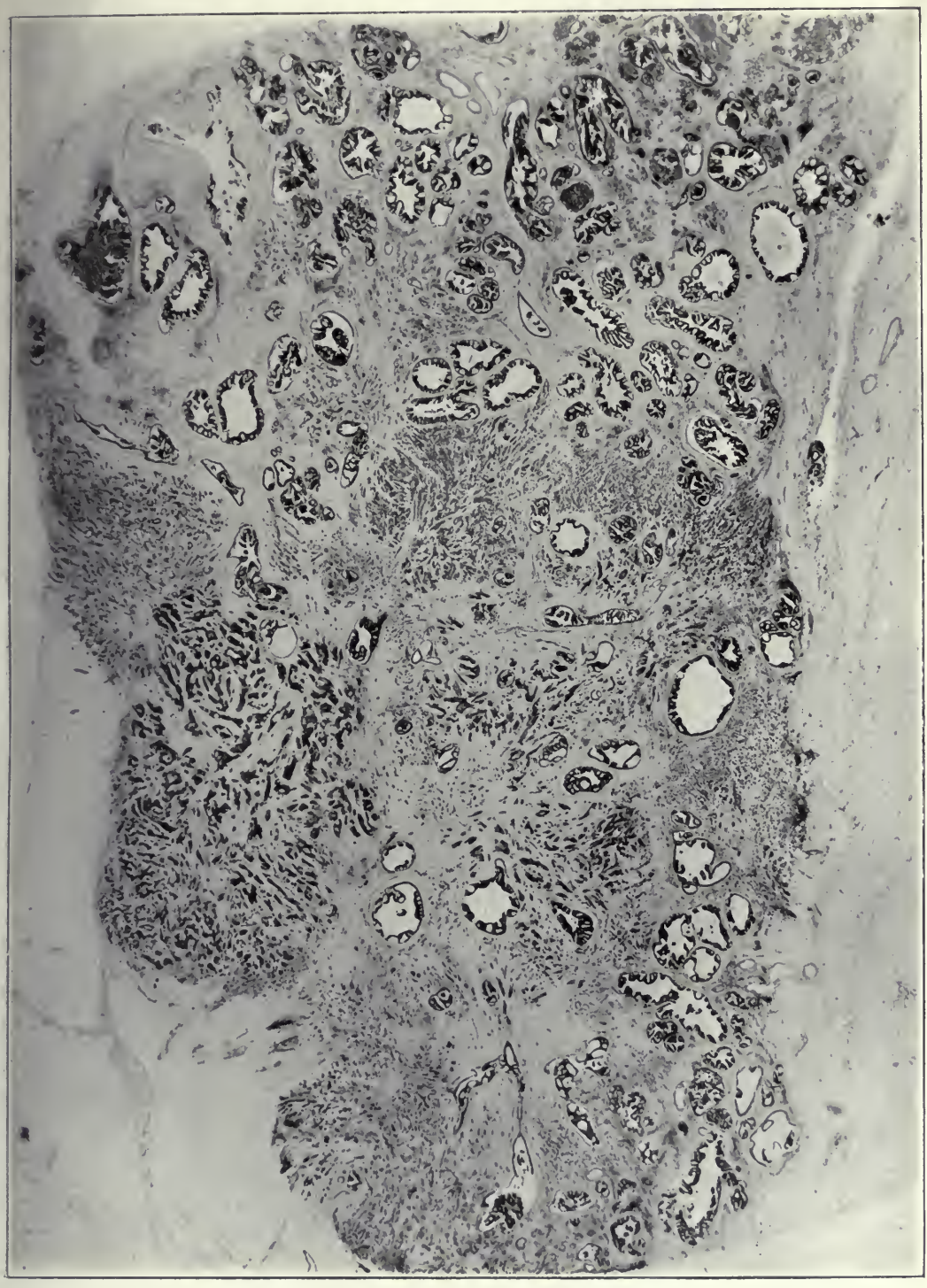

FIG. 100.—From a whole section of breast in which the same grouping of epithelium within the cysts occurs. But in addition the fat and fibrous tissue are invaded by epithelial elements. In the lower part of the section, where fat is being infiltrated, the epithelium can be seen inclining to the same curious grouping as observed within the cysts. The disease has advanced further in this breast than in that of *Fig.* 98.

Figs. 101 and 102 are parts of the same breast more highly magnified. It will be seen that the contents of the cysts in *Fig.* 100 are identical in appearance with those in *Figs.* 98 and 99. Within the cysts in each tumour (*Figs.* 98 and 100), the epithelial cells are grouped together in curious typical forms. They resemble lacework. I venture to call it 'laciform'. Equally typical, and a variation of the laciform appearance, the epithelial cells are so grouped as to resemble the spokes of a wheel—a regular cart-wheel appearance is seen in *Fig.* 104A. These finer papillomatous changes are seen as well as the coarser. The coarser papillomatous change is well observed in the cyst A, *Fig.* 98.

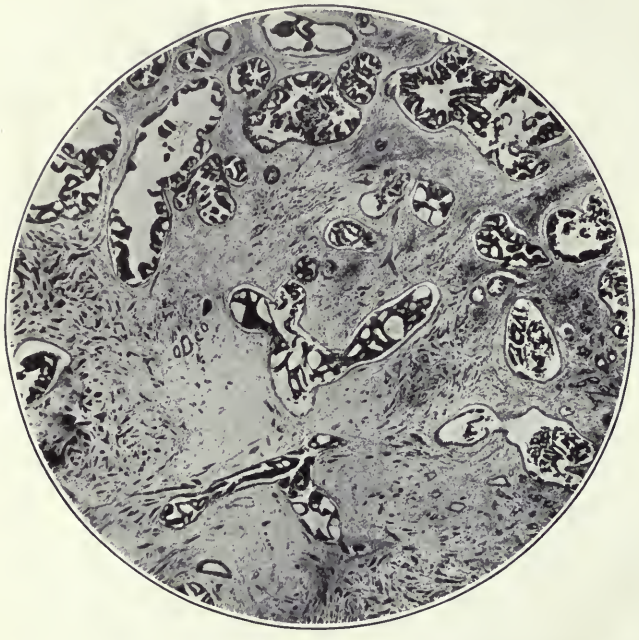

FIG. 101.—From same section as *Fig.* 100 under higher magnification.

Nobody could doubt the malignancy of the disease in the breast of *Fig.* 100, and very few would doubt it in *Fig.* 98 : I regard it as malignant. Furthermore, those extracystic parts into which the epithelial cells have spread, and which are, comparatively speaking, spacious or capable of being rendered spacious, will be seen to show an inclination of the epithelial elements to group themselves into the same laciform appearances as those seen within the cysts.

It may be definitely stated that these laciform and cart-wheel appearances are typical of this form of cancer, and from what I have seen it can be observed only in this type, and is therefore diagnostic.

I have seen cancers of this type in which the disease appears to have been more abundant where it was spreading outside the cysts, compared with the growth

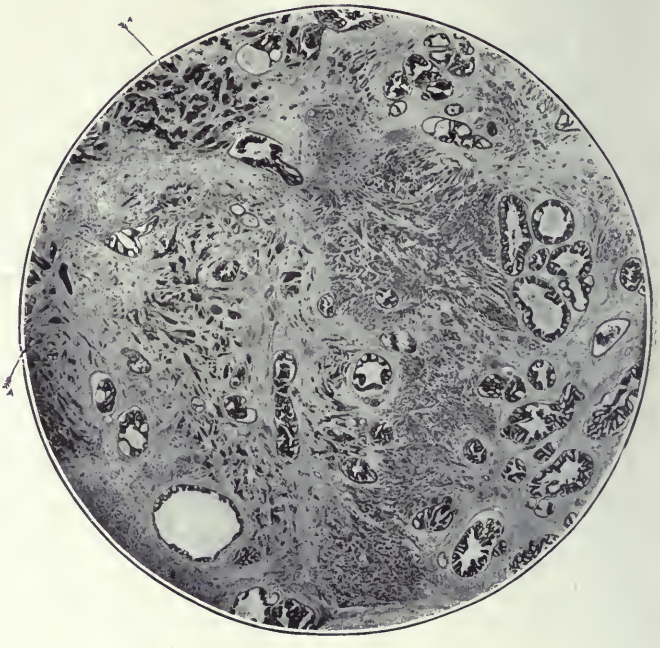

FIG. 102.—The same as *Fig.* 101.

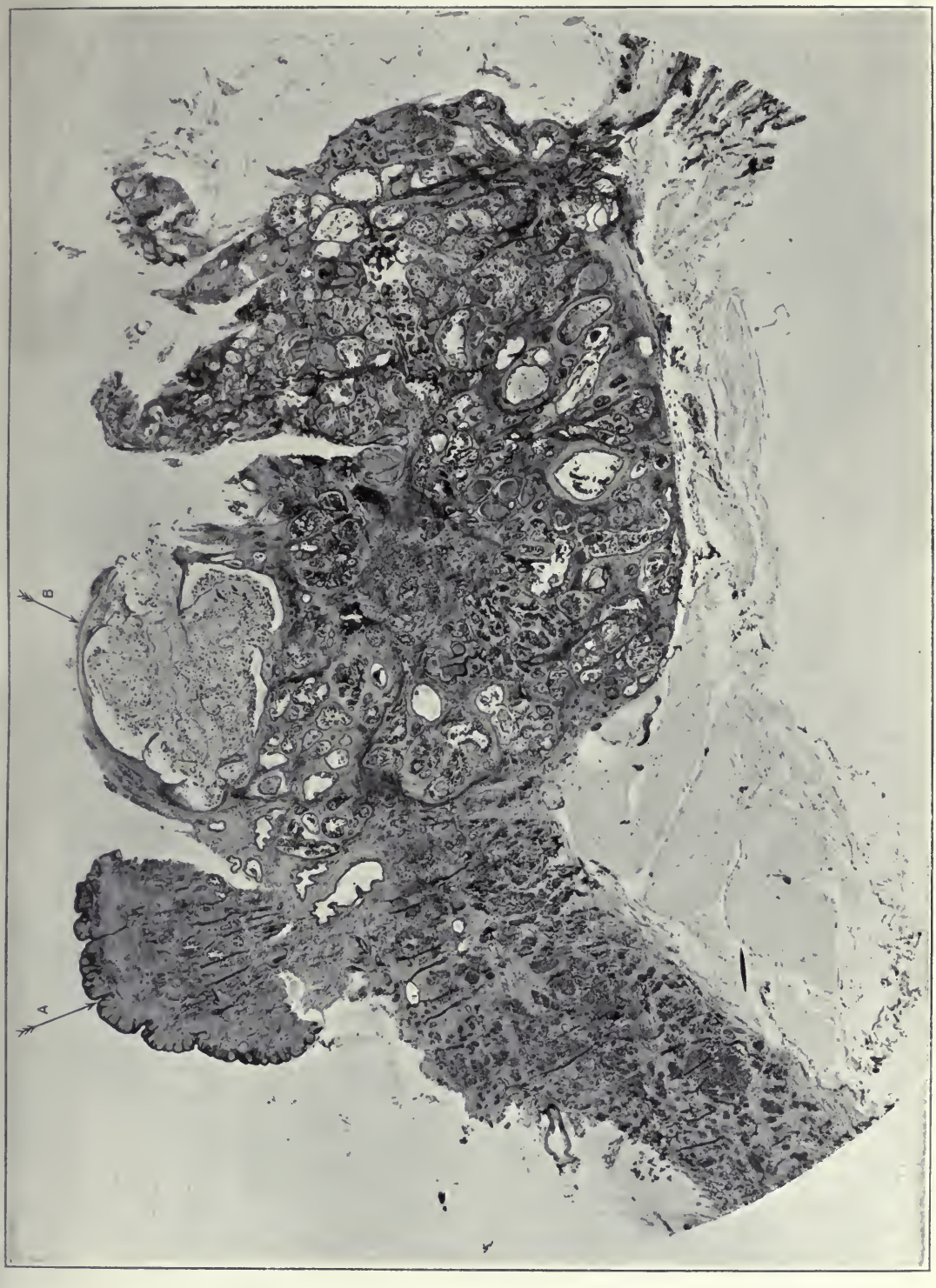

FIG. 103.—Whole section of breast in which the disease has advanced further than that of *Fig.* 100. Epithelial grouping within the cysts is the same, but neighbouring cysts have in some parts become confluent. Fibrous tissue has been invaded. At **B** colloid degeneration of parts of the tumour has occurred. The cancer is situated mainly in the cystic part of the breast on the right of the section. **A** points to the nipple, the ducts of which are embedded in dense musculature immediately below which dilatation of some ducts has occurred. No ducts within the nipple were dilated.

FIG. 104.—A higher magnification of a part of *Fig.* 103, showing the cart-wheel appearance described in text, A.

within their walls, a fact which need surprise no one familiar with the enormous degree to which cancer of the breast may spread throughout the body.

Fig. 103 is a photograph of another breast in which the cancer is most obvious in the right half of the section. The cancer is of the same type as in the previous sections, but it is in a still more advanced degree. Barriers between neighbouring cysts have disappeared and rendered the cysts confluent, parts of the tumour have undergone colloid degeneration at B, and, although confined mainly to the breast itself, the epithelial cells have invaded its fibrous tissue and the lymphatic glands in the axilla. Yet in *Fig.* 104 (which is a more magnified part of *Fig.* 103) can still be seen the same characteristic appearances. I have serial sections of this breast, and in them I can trace the course of an enormous cancer-bearing duct from the nipple to the extremity of the periphery of the breast. The following is the course taken by it of some of its branches.

It begins at the nipple and first runs parallel with the skin. It then bifurcates.

The upper branch continues parallel to the skin, and towards the periphery bifurcates; the upper branch ends in a malignant cyst, the lower branch passes out of the series.

The lower branch passes

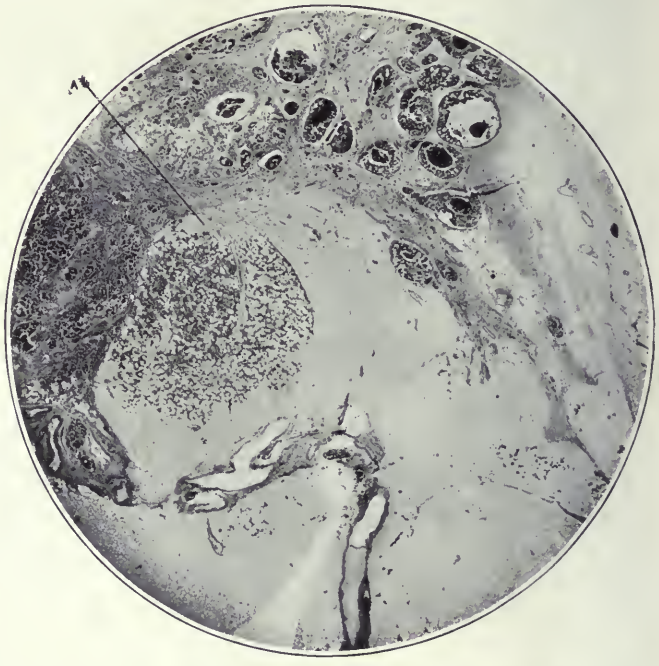

FIG. 105.—Shows an edge of a breast tumour, the type with which this article deals. A indicates its spread in fat.

FIG. 106.—Part of whole section of breast in which the disease was very malignant. Cysts are seen containing the lacework and cart-wheel grouping of epithelial cells. Epithelial cells are invading fibrous tissue of the breast.

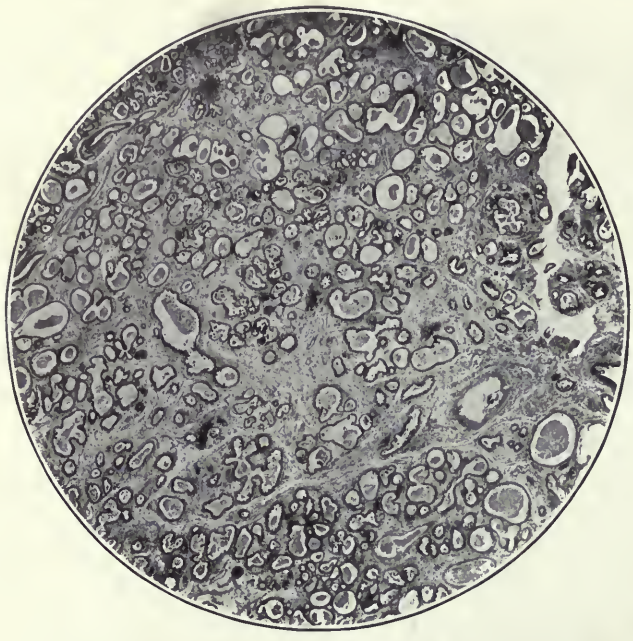

FIG. 107.—Part of section of breast tumour composed entirely of this structure. All the spaces appear to be ducts. Here and there there is a very small amount of epithelial invasion of fibrous tissue.

at an angle of 45° from the main duct, downwards to the pectoralis major, but at the extreme periphery the two branches into which it had bifurcated pass out of the series.

Fig. 106 is a photograph of a breast in which the cancer is behaving in precisely the same way. This patient died of the disease, which appeared to be most malignant and rapid in its course.

Figs. 107, 108, and 109 are photographs of a breast tumour unique in my experience. The whole tumour was unencapsuled, and appeared to be composed of ducts. Some of the ducts examined under higher power (*Fig.* 108) show the same laciform appearance that I have described in the previous tumours. *Fig.* 109 is taken from the edge of the growth. No lymphatic glands were implicated, and the patient from whom it was extensively excised is still well, over ten years after the operation.

There are many ways in which cysts assist in the spread of cancer: (1) Two cancer-bearing cysts coalesce; (2) A cancer-bearing cyst invades a simple cyst; (3) A cancer-bearing periduct lymphatic vessel may invade a simple cyst or a cancer-bearing cyst.

Many of us are inclined to hope and believe all is well when no lymphatic gland in the axilla can be found cancer-bearing. I am very sorry to say that I have found the lymphatic vessels as they pass over the first rib to be cancer-bearing when no cancer could be detected in any lymphatic gland of the axilla.

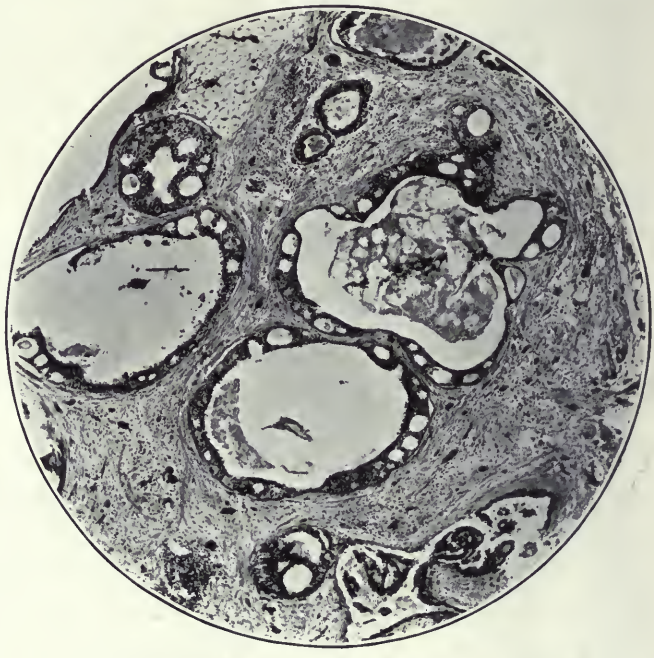

FIG. 108.—Shows a higher magnification of some of the ducts seen in *Fig.* 107. The lacework formation is typical, and there is epithelial invasion of lymphatic vessels. The cysts are gradually becoming confluent.

It would be very interesting and instructive to decide which of the two types of simple cysts described in I, *A* and *B*, are the chief foci in harbouring the incidence of cancer. I believe they are mainly those described under *A*, for the following reasons. In all malignant tumours of this class there is to be seen at some part (more or less in degree) the thicker and coarser papillomatous tissue associated with duct cancer as we know it (see bottom of *Fig.* 114 and the cyst in *Fig.* 115). Also if cancer-bearing duct-cysts were cut transversely instead of longitudinally as in A, *Fig.* 98, they would show exactly the same appearances as those seen in other cysts of *Figs* 98 and 99, and in the cysts of *Figs.* 100, 101, 102, 103, 104, 105, 107, and 115. I have many sections that prove this point. Also in *Fig.* 114 the coarse papillomatous tissue is seen in one cyst, and higher up on the left of the photograph is seen another containing the laciform structure. Again, the cyst in *Fig.* 115 contains both elements, the coarse papillomatous and the laciform.

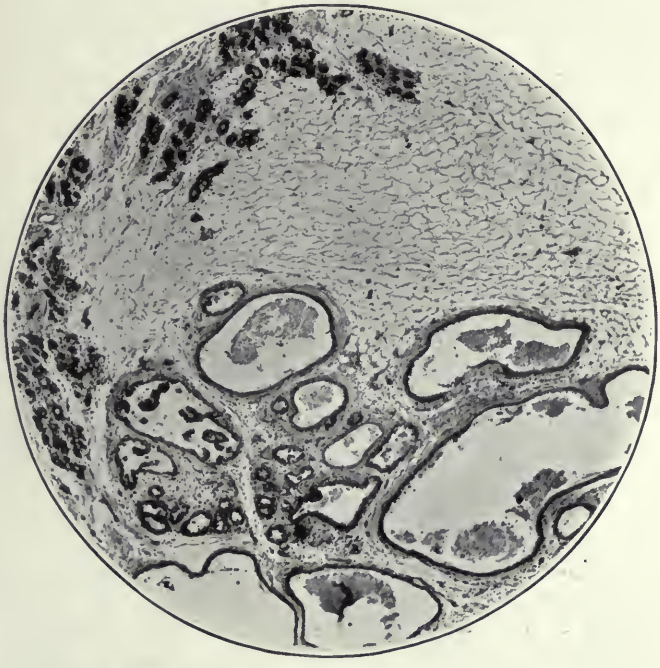

FIG 109.—Shows the edge of the tumour depicted in *Figs.* 107 and 108.

Finally, in those tumours where the coarse papillomatous tissue can be seen in the process of permeation, the permeated epithelial cells do not form coarse papillomatous structure, but resemble the laciform fabric, and then only where space is available for its peculiar and particular formation. I regard the last as so important an observation that I hope the editors of this journal will allow me the opportunity of showing in greater detail the microscopical appearances and my interpretation of them in this particular form of very interesting and instructive tumour. It would add to my argument, and I hope would soften and subdue many criticisms that may be made on this article.

But I have whole sections of a malignant cystic breast which appears to me to be made up of the acinus type of cell and most fine papillomatous structure.

The observations of my paper are not intended to be only academic. Take, for instance, the breast from which *Fig.* 113 is a photograph. Blood is to be observed in almost every duct, and it occurred in this way. I removed a large portion of the breast for the purpose of diagnosis. The part of the breast shown in *Fig.* 113 was left behind at that time, and

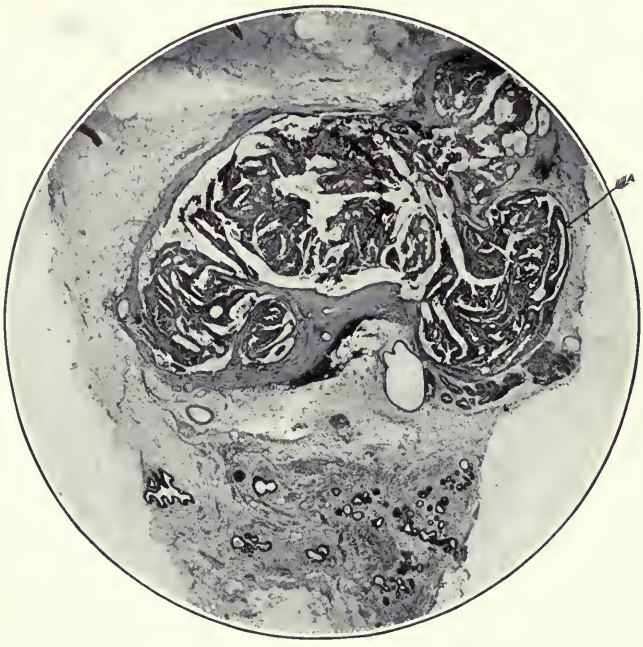

FIG. 110.—Shows cysts and intracystic growth from a breast removed post mortem. The death of the patient was caused by disease unconnected with mammary tissues.

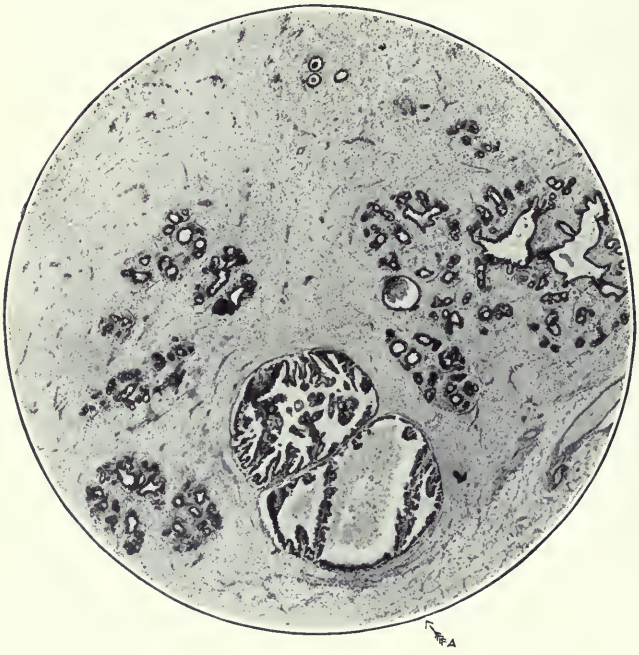

FIG. 111.—Shows cysts and intracystic growth in another breast removed post mortem. The patient died from disease unconnected with mammary tissues.

was removed a week later on the verification of cancer existing in the parts removed. Upon the examination of the parts shown in *Fig.* 113, to my surprise I found nearly all the ducts full of blood. At the preliminary operation and afterwards there was no hæmorrhage ; everything healed normally. Blood could not have been forced by great pressure into these ducts ; there was no pressure. Therefore it shows the ease with which foreign matter can spread in ducts when once entrance is gained. Hence, how important it must be to guard against the entrance of foreign matter that may be irritating as a traumatic or an infective agent. It must be admitted that, in the case I am describing, entrance of the blood was not gained through normal channels, but through channels unguarded by nipple structures. The ducts in the normal nipple are surrounded by dense musculature which may act as an accidental means of closing ducts by its density, or as an intentional agent by which they are closed by muscular contraction induced by a reflex act that is stimulated by the entrance of irritating or infective foreign matter. The latter action is more than extremely probable.

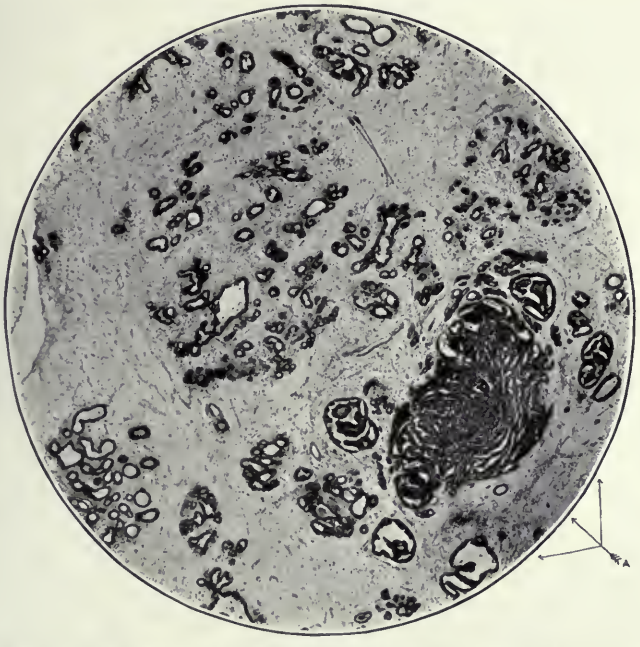

FIG. 112.—Shows more duct changes in a breast removed post mortem, death being due to cases unconnected with mammary tissues. Cysts with intracystic growths are to be seen. Some collections of lymphocytes are in their neighbourhood, but there is no epithelial invasion of lymphatic vessels. There were other cystic changes in the same breast.

Having seen the ease with which foreign matter becomes distributed when entrance is once gained, it is important to suggest every precaution in one's power to prevent its entrance. Therefore I advise that all nipples should be cleansed with boiled water, and that the use of any means for cleansing or so-called 'hardening' the nipples which contains irritants should be rigidly and permanently abandoned ; also that the use of soap and anything likely to obstruct ducts should be avoided. It is important to state that soaps may, in some brands especially, contain very irritating substances, the action of which would be far greater when applied to an epithelial surface unaccustomed to irritants, like the duct epithelium, than it would be when applied to surfaces accustomed to, and prepared by nature to, resist them, like the skin epithelium.

The prominent practical issue that arises from this paper is the treatment of cyst-containing breasts. The more one studies this great and important problem, the

greater appear the difficulties, for the following reasons. If one breast be cystic, the other commonly contains cysts. If only one big cyst be obvious clinically, there is in most cases a large cystic element elsewhere in the breast when examined microscopically. I have no evidence that cystic breasts are prone to cancer; my evidence shows only that cancer can originate in cysts, and in some breasts the cysts are so small that they cannot be distinguished upon a clinical examination, and become obvious only on investigation with the aids of the microscope and whole sections. I have no evidence to show that a

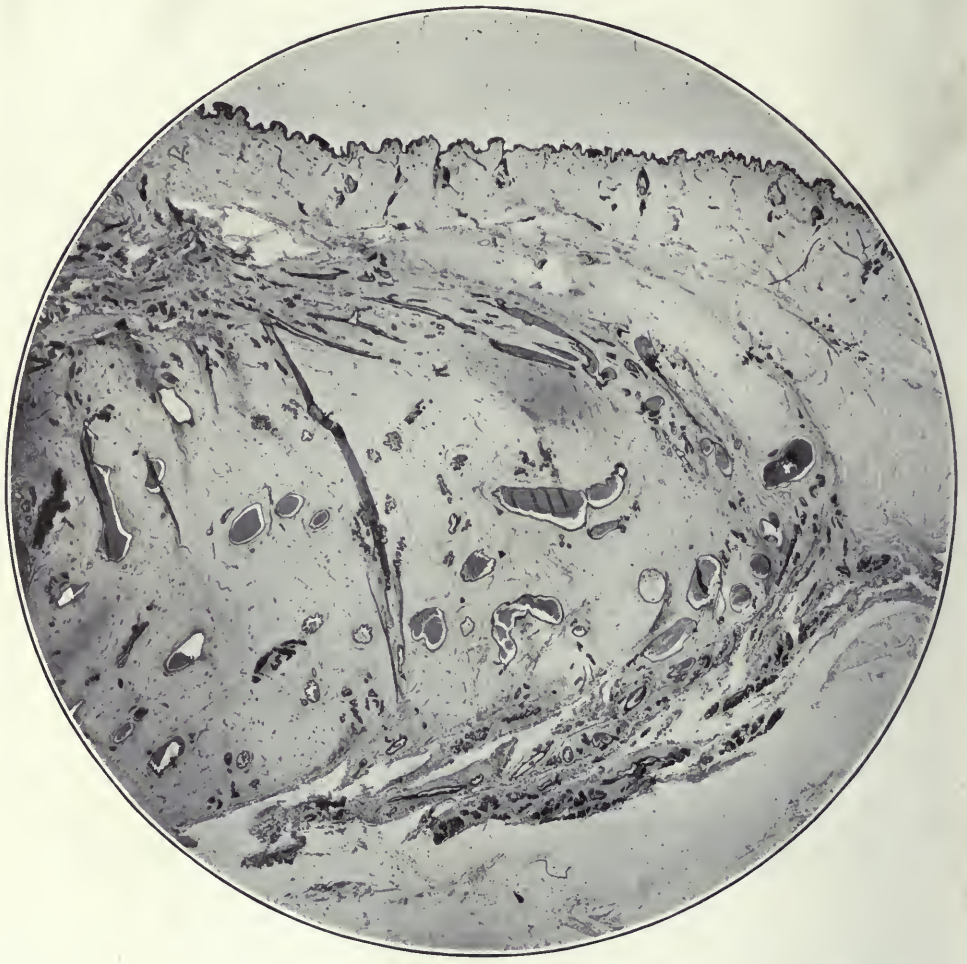

FIG. 113.—Half of a whole section of breast from which a part had been removed a week previously for diagnostic purposes. Nearly all the ducts contain blood.

large cyst is more dangerous than one that is microscopical. I can show only that cysts of all sizes may contain simple papillomata and primary cancer.

The problem of treatment is made no easier if breasts be examined, post mortem, of patients who have died from ailments totally unconnected with mammary disease. For a good many years I have examined breasts from the post-mortem room, and *Figs.* 110, 111, and 112 are photographs of abnormalities seen quite commonly in many of these breasts. The cyst (*Fig.* 111) containing intracystic papillomatous growths is quite a

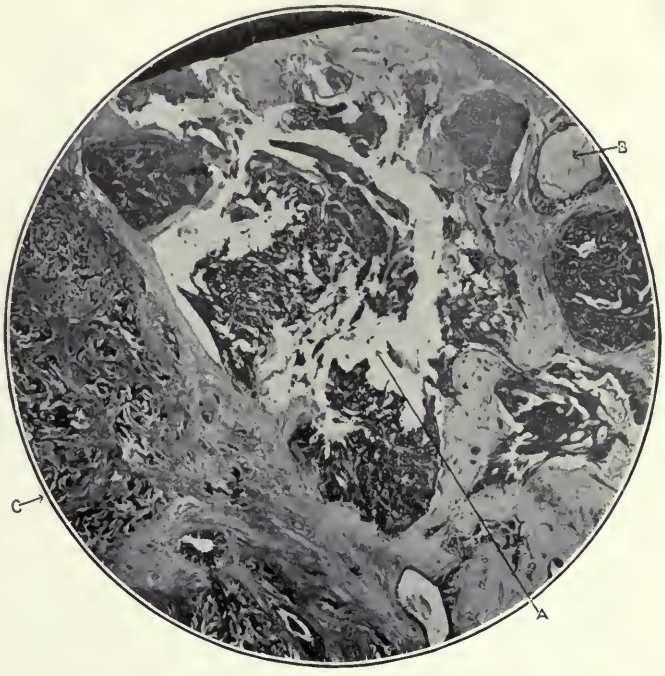

FIG. 114.—Part of a whole section. The disease was very advanced, and the site of the breast contained little or no normal glandular structures. This is a photograph from a part of the tumour's edge. The structure of the tumour, which was large, is seen on the right, and the spread of the disease is seen on the left, where the papillomatous part of the tumour is more pronounced and coarser than in the preceding tumours (A). But at B can be seen part of it which exactly resembles appearances which are so obvious in these tumours. In making a report upon this case it was obviously necessary to examine the tumour and the tissues into which the disease spreads. If a small section had been made only of those parts into which the cancer had spread (C), then it would have been reported as being an ordinary scirrhus of the breast.

FIG. 115.—Photograph of a malignant cyst which contains the coarse papillomatous structure, as well as the finer laciform fabric.

common discovery in presumably normal breasts. The ducts seen in *Fig.* 112 are of very ugly and threatening aspect. Fortunately so sinister an appearance is not generally observed, but I have whole sections of breasts removed for cystic disease which show very similar changes.

In the face of this evidence it would be unwise and useless to suggest that all cystic breasts should be excised; for, if my remarks be true, it would be necessary to examine microscopically the breasts of all women about middle age, and in a very large proportion cystic changes would be found.

After consideration I am bound to say I would advise the removal of every breast which is obviously clinically cystic. I would advise this course if only a single cyst were clinically present, for the reason I have given. In practice I leave the nipple and axillary lymphatic glands. Some surgeons, I know, are removing cystic breasts as the means of getting rid of cystic breasts, and my evidence compels me to believe that breasts that are known to be cystic ought to be excised with the object of preventing a far greater calamity. I am sure cysts can be dangerous. In most cases totally unsuspected simple intracystic papillomatous tumours (of duct and acinus types) can be found in them, and in a recent case of Mr. Burghard's I found not only simple papillomatous tumours, one of which was the size of a capital O in this print, but an unsuspected cancer as well.

It seems to me perfectly fair to compare recent work on the changes in ovarian cysts with the changes I have described in the breast cysts. They will be seen to be identical.

I am indebted to Mr. Joseph E. Barnard for the trouble he has taken in photographing my specimens.

FOUR ANEURYSMS IN THE NECK.

By R. LAWFORD KNAGGS, Leeds.

The following interesting group of cases—(1) *A varicose aneurysm* (arteriovenous); (2) *Two traumatic aneurysms at the root of the neck*, treated by distal ligature; and (3) *One carotid aneurysm*, treated by proximal ligature—includes all the aneurysms in the neck with which the writer had to deal in the war.

It is well known that when arteriovenous aneurysm is met with in the neck it is less serious in its progress than the same condition in the extremities, especially the lower extremities. But it is not such common knowledge that spontaneous cure may result.*

Traumatic aneurysm at the root of the neck, however, is a more serious matter, and must always give rise to anxious thought before operative treatment is decided upon. It is true that such an aneurysm might be due to a wound of the transversalis colli, or possibly the suprascapular artery, and prove less serious than was anticipated; but as a rule it is either the subclavian, or one of the large branches of its first part, such as the vertebral, or the thyroid axis, close to their origin, or the carotid near the bifurcation of the innominate, that has been injured. In such cases any operation above the clavicle, whether ligature of the innominate or the first part of the subclavian, or excision or obliteration of the sac, involves surgical procedures of the gravest character, even if all goes well; but if complications arise—a not unlikely possibility—they may be attended with the most urgent dangers, and the surgeon may esteem himself fortunate if he is able to meet them successfully before the patient succumbs.

It was after a conversation with Mr. Jonathan Hutchinson that I first began to think seriously of the distal ligature. He had once tied the first part of the axillary artery for a spontaneous aneurysm of the subclavian, and had no reason to think that the patient had not remained permanently cured. My experience of the distal ligature was limited to its use in thoracic aneurysms, and what I had seen had not impressed me with its value, so that my feeling about it, then, was very much that voiced by Sencert, who speaks of distal ligature as a makeshift operation. But on a careful review of the 'pros and cons' it was evident that in suitable and properly-selected cases there was a good deal to be said in its favour.

My experience of the traumatic aneurysms that found their way over to England had taught me that the communication between the sac and the artery was usually quite small, and the aneurysm a well-marked saccular one. Such aneurysms, moreover, occurred in young soldiers whose arteries were healthy, a factor of some importance, for there was less danger of enlargement of the communication. The local conditions, therefore, were eminently favourable to consolidation of such a tumour if only the blood-stream could be sufficiently slowed and weakened.

So far as could be judged from the position of the swelling in *Case* 2, the communication between the sac and the vessel was likely to be in the second part of the subclavian artery. If a ligature were placed on the axillary artery in its first part, above the acromiothoracic branch, a length of vessel almost without branches would intervene between the mouth of the sac and the ligature. The only branch of any importance would be the superior intercostal, and it would probably take some time before this would enlarge

* I believe a very similar case was shown at one of the Societies during the war, but I am unable to give the reference.

sufficiently to enable a strong blood-stream to flow past the aneurysmal opening. And it was just possible that the opening might be on the distal side of the origin of the superior intercostal. There was also another point, which would be of some moment if distal ligature were to fail and a more direct operation become necessary: ligature of the axillary artery would leave the tissues above the clavicle undisturbed.

For these reasons it was decided to employ the distal ligature in *Case* 2.

In *Case* 3 there was much greater uncertainty as to the position of the mouth of the sac—as to whether the subclavian, the carotid, or the vertebral had been wounded. This made it difficult to decide which artery to tie. The probable course of the metal fragment lying behind the sternum decided me to tie the carotid, and fortunately there has never been reason to regret it.

The last case calls for no particular comment. It was a question of judgement whether it would be more in the interest of the patient to complete the dissection and remove the sac or to tie the artery. As the aperture was likely to be small, success after proximal ligature seemed almost certain, and evidently the right decision was made.

PARTICULARS OF CASES.

Case 1.—**Arteriovenous aneurysm of common carotid artery. Varicose aneurysm. Spontaneous cure.**

Pte. F. S., age 23, received a shrapnel wound on the left side of the neck on Oct. 4, 1917, near Ypres.

During a short stay in the York Military Hospital, a visible aneurysmal swelling was noted, and he was transferred to a military ward in the Leeds General Infirmary, Dec. 5. On admission, there was a distinctly visible, pulsating swelling, as big as a filbert, opposite the left ala of the thyroid cartilage. The swelling ceased below at the level of the cricoid. There was a thrill over it, and this was very marked just above the swelling. There was a very loud, continuous whirring bruit, with systolic exacerbations, heard over the swelling and upwards over the vessels as high as the ear, and downwards along the course of the common carotid in the neck and over the first piece of the sternum. It ceased when the common carotid was compressed below the swelling. A skiagram showed a pointed piece of shrapnel opposite the 4th cervical vertebra, close to the bone on the left side, and just below the side view of the body of the hyoid bone. The cicatrix of the small wound of entrance was on the level of the body of the hyoid.

His only trouble was the noise of the bruit in his left ear when he lay with the left side of his head on the pillow. The heart's apex was normally placed; there was no cardiac bruit, and the second sound was accentuated.

The patient was put to bed, and the excitability of the pulsation which was present when he was walking about soon subsided. On Jan. 11 the swelling had not increased and was a little harder; the bruit was not so loud nor the pulsation so marked as when he came in, or when allowed out of bed, and the thrill was not felt. By Feb. 26 a further change was apparent. The intensity of the bruit had much diminished. It was doubtful even if it was continuous. There was a soft systolic murmur—rather distant—and the pause was of very slight duration. Yet on March 6 its continuous character was again recognized, but the area over which it could be heard had become very restricted. On April 9 no bruit had been heard for several days. The thrill was still absent. The swelling was no longer visible. It could be felt as a small hard swelling, no bigger than a pea, about the level of the middle of the thyroid cartilage. The pulsation connected with it was thought to be transmitted from the artery. On April 28 there was no pulsating swelling, no bruit, no thrill. A small mass of thickening was left which presented two spots of greater hardness, one of which was almost a nodule.

Recovery was now regarded as complete, and he was allowed to get up. With the exception of a few days at the time of his transference from York to Leeds, he had been in bed for about thirty weeks. On June 3 he was transferred to Gledhow Auxiliary Military Hospital (V.A.D.), and after a couple of months' convalescence he was invalided—apparently quite cured.

In the early part of 1920 he wrote that he was working in the pit, and it is evident from his letter that there had been no relapse.

Case 2.—**Traumatic aneurysm at the root of the neck. Distal ligature. Cure.**

Spr. G. H. B., age 26, was wounded on Sept. 26, 1915. A rifle bullet entered the back of his neck, passing through the right trapezius, and lodging, as was subsequently shown, behind the inner end of the right clavicle, one inch from the anterior surface of the neck.

On admission to the 2nd Northern General Hospital, Oct. 2, the wound of entry was not healed, but it gave no trouble, and the bullet-track closed aseptically. The patient was kept quiet and carefully watched for the possible development of an aneurysm; but it was not till Nov. 4 that

he drew attention to a swelling which had made its appearance only a day or two before, above the inner end of the clavicle. The swelling was about the size of a damson, and lay under the clavicular head of the sternomastoid. It was elastic, and pulsated, the pulsation being almost certainly expansile. There was a short systolic bruit heard over it. Some pain was experienced along the course of the ulnar nerve, but there was no sign of venous pressure. The swelling increased a little during the next week or two, till it became as big as a small bantam's egg. It formed a visible tumour and could be seen to pulsate. So long as the patient was kept completely at rest in bed it remained stationary, and was thought to become both smaller and harder. But when, after many weeks, he was allowed to get up, it soon became larger and more prominent, and he was again confined to bed. During the period of treatment by rest he also had weekly injections of horse serum, and chloride of calcium intermittently.

But at the beginning of May it became clear that cure could not be expected by medical treatment, and the man also wished to have an operation. On May 10, therefore, the first part of the axillary artery was tied about one-third of an inch above the origin of the acromiothoracic artery, after detaching the outer part of the clavicular origin of the pectoralis major, and drawing that portion of the muscle downwards and inwards. The wound healed by first intention, and on May 19, when the stitches were removed, the aneurysm was much less prominent, was smaller and much firmer, and no bruit could be heard. The third part of the subclavian could be felt to pulsate, and though the tumour pulsated, the pulsation was thought to be communicated and not due to expansion of the sac.

On June 14 it was noted that "though there is definite fullness below the sternomastoid, yet no pulsation has been visible since the first dressing. The tumour is firm, and about as large as a gooseberry. There is no bruit, but only a kind of thud. The transversalis colli artery can be traced by its pulsation across the posterior triangle. Feeble pulsation can be felt in the brachial, about the insertion of the coracobrachialis, and also in the radial".

In August, when he was discharged from the army, there was an indurated swelling, with some surrounding thickening, at the site of the original pulsating swelling, and there was every reason to believe that a cure had resulted. The man's home being in London, I got him to report himself at the London Hospital to Mr. Jonathan Hutchinson, who told me that when he last saw him he thought that he was quite well, and he had given him permission to do some work.

On March 3, 1917, the man himself wrote: "I am pleased to let you know I am going on very satisfactorily without the least trouble"; and again on March 7, 1920, that he had "been working pretty well all the way through", and was now driving a motor car. He had not had the slightest trouble with his neck.

Case 3.—**Traumatic aneurysm at the root of the neck. Distal ligature of the common carotid. Cure.**

Pte. W. F., age 19, received a gunshot wound of the neck on May 3, 1917. He was under treatment for paresis of the left (?) deltoid when he was transferred to the orthopædic department of the 2nd Northern General Hospital in July.

On July 29 he was transferred to a surgical ward for a pulsating swelling at the root of the neck, and was under the care of Captain G. P. Anning. The following notes were made:—

"On the right side of the neck there is a horizontal scar, 2 in. long, lying across the posterior triangle. Its anterior extremity is just behind the posterior border of the right sternomastoid muscle and 1½ in. above the clavicle. This is the entrance wound. There is the scar of an exit wound 1 in. to the right of the dorsal spine. A small ovoid swelling presses forwards the lower portion of the sternomastoid muscle, and presents behind its posterior border in the posterior triangle. It lies entirely external to the line of the carotid artery and reaches as low as the clavicle, and possibly passes beneath it. It pulsates, and the pulsation is expansile, and a sharp, harsh bruit can be heard over it and along the course of the subclavian and carotid arteries. There is no sign of pressure upon the big veins, nor at this date, of any interference with the branches of the brachial plexus."

Later, a skiagram revealed the unexpected presence of a piece of metal behind the first piece of the sternum, close to the left sternoclavicular articulation, which was located at a depth of 1¾ in. from the surface. There could be little doubt that this had traversed the tissues close to the bifurcation of the innominate. The tumour increased in spite of rest in bed, and on July 31 was described as a soft swelling, the size of half an apple—by no means all sac—and extending as high as the upper border of the cricoid cartilage. The sac itself was more prominent at the posterior border of the sternomastoid, and on the inner side of that muscle an artery could be felt, either the innominate or the carotid, but not a part of the sac.

On Aug. 1 the common carotid was ligatured above the omohyoid. At the first dressing (Aug. 5) the soft swelling had disappeared, the sac was decidedly smaller and gave a feeling of greater solidity, and the bruit was much less marked. Pulsation continued. By Aug. 28 there was no bruit. Pulsation was much less obvious on inspection, and on palpation it was doubtful if it was more than a transmitted one. The patient was now quite unconscious of the beating, which had worried him before operation.

On Dec. 11 there was no tumour, no pulsation, and recovery was apparently complete. Lieut.-Colonel Wardrop Griffith, who had seen the patient on several occasions, had regarded the condition as quite cured some time before this date.

Case 4.—**Traumatic aneurysm of the carotid. Proximal ligature of the common carotid. Cure.**

Pte. M., 2nd Coldstream Guards, was wounded on Dec. 12, 1916. When he came under observation in the 2nd Northern General Hospital on Dec. 27, there was a small wound over the left temporomandibular joint (of no importance), and another very small healed wound in the neck, 1½ in. below and behind the left angle of the mandible. In front of the latter wound was a pulsating swelling, the size of a chestnut. The pulsation was not expansile, and there was no bruit. The swelling was not rounded, and it extended backwards and inwards, and felt like a mass of inflammatory tissue. On Jan. 26, 1917, a short, sharp, systolic murmur had developed, and the pulsation was expansile. The external carotid felt thicker at its most superficial part, when compared with that on the other side, and the main swelling blended with this thickened part, lying on its outer side.

Operation, Jan. 27. Ether. Through an incision 6 in. long in front of the anterior border of the sternomastoid, the left common carotid artery was exposed, and a temporary ligature applied at the level of the cricoid cartilage. A dissection of the sac was made, and its whole anterior surface and sides were exposed. It extended from the level of the bifurcation to the posterior belly of the digastric, its upper limit being covered by that muscle. The matting of the parts was so firm and so considerable, and the difficulty of recognizing anatomical structures involved in it so great, that it was evident removal of the sac would be very difficult, and that important structures would be in danger of injury. Therefore, as compression of the common carotid completely stopped pulsation in the sac, this vessel was ligatured about the level of the lower border of the thyroid cartilage, and the operation concluded. The small fragment of metal which had caused the mischief was not sought for.

On Feb. 7 the wound was healed, the visible swelling caused by the tumour had disappeared, and so had the pulsation and the bruit. On May 14 the tumour had completely disappeared, only a little thickening remaining at its site. There was no bruit, and the condition appeared completely cured. He was recommended for reclassification.

THE CAUSATION OF APPENDICITIS.

By A. RENDLE SHORT, Bristol.

The facts with regard to the history of appendicitis, and its racial distribution, are so clearly defined and unusual, and the disease is so common and plays such an important part in modern surgery, that it is passing strange that we have come to no settled conclusion as to its causation The problem looks so simple. When a disease leaps into extreme prominence within a decade or two, becomes an everyday occurrence in the hospitals of certain more civilized countries, and leaves the rest of the world alone, surely the riddle of its causation should not be hard to read. Yet it has proved so.

The method followed in this study is to present first the facts regarding the increase of appendicitis and its distribution ; then to seek to elucidate the ultimate cause by correlating these facts with the various advances of modern civilization ; and lastly, to inquire what actually precipitates an attack.

I. THE ALLEGED INCREASE OF APPENDICITIS.

There are three means by which we have attempted to deal with this question : (1) By a study of the literature ; (2) By the statistics of the Registrar-General of deaths : and (3) By a series of hospital figures.

The Literature of Appendicitis.—The first recorded case appears to be that of Mestivier[1] in 1759. Three others were reported in France before 1808, and the first English case, published by Parkinson[2] in London, was in 1812. The derivation of abscesses in the right iliac fossa from perforation of the appendix was clearly laid down in 1827 by Mélier,[3] but for many years the general opinion was against the appendicular origin, and the true etiology was concealed under the term ' perityphlitis '. Between 1820 and 1840, 33 cases were reported ; between 1840 and 1860, 102 ; these were fairly distributed between France, England, Germany, and North America. The epoch-making treatise that finally and thoroughly established the main points about the disease and its treatment was that of Fitz, of Boston,[4] in 1886, and he introduced the name 'appendicitis'. It was he, too, who declared the importance of early operation. There is some difference of opinion as to who first diagnosed the condition and proceeded deliberately to remove the appendix ; the claimants are Krönlein[5] in 1884, Treves[6] in February, 1887, and Morton,[7] of Philadelphia, in April, 1887.

From this time onward, the annual literature has grown to enormous proportions, especially since 1900. Sir Frederick Treves in this country, and McBurney in America, were leading pioneers. The profession had already realized that the disease was common and important, but popular interest in it dates very definitely from the time when Sir Frederick Treves operated on King Edward VII for an appendicular abscess on the eve of his coronation. Since then appendicitis has been a household word, and everybody knows something about it.

Fuller details of the history of the disease are given by Kelly.[8]

Registrar-General's Returns.—A second method of verifying the alleged increase in the incidence of appendicitis is by a study of the Registrar-General's mortality statistics. This method, however, needs careful allowance for its many limitations. Unfortunately, appendicitis did not become a separately notifiable and recorded cause of death until 1901.

Following is death-rate from appendicitis per million living, for England and Wales :—

Year	..	.. = Death-rate	Year	..	.. = Death-rate
1901	..	.. = 38	1911	..	.. = 75
1902	..	.. = 45	1913	..	.. = 68
1903	..	.. = 52	1915	..	.. = 67
1905	..	.. = 57	1917	..	.. = 67
1910	..	.. = 66	1918	..	.. = 72

The number of deaths from appendicitis in 1918 was 2416, being 1298 males and 1118 females. The age of greatest mortality is between 5 and 15.

In 1913 the Registrar-General presented a special report on appendicitis, showing that there is no seasonal variation of incidence, but that there is a remarkable parallelism in various months and various years between the death-rates from appendicitis and from diarrhœa. In rural districts there was a slightly lower death-rate per million living than in towns, the proportion being 66 to 71. Bearing in mind the greater difficulties of getting early surgical treatment in the country, and therefore probably a higher death-rate, in all probability the true incidence of the disease would show a greater preference for the town population than these figures indicate; in 1913, therefore, the town was decidedly more liable to the disease than the country.

In 1917, however, the deaths are higher proportionately in the rural districts than in London.

	Deaths from Appendicitis	Total Deaths, all Causes	Proportion
London ..	268	63,406	0·42
Rural ..	461	95,997	0·48

This difference may very well be due to an equal incidence of the disease, but prompter operative treatment in the metropolis.

There is very little doubt, from hospital statistics and from experience in private practice, that the mortality from appendicitis is lower now than it was fifteen years ago. At that time the death-rate was probably over 10 per cent; nowadays it is well under 5 per cent. In 1912 the mortality at the London Hospital amongst cases of acute appendicitis was 4·3 per cent; at Edinburgh, from 1910 to 1913, it was 7·3 per cent. In 1905, the London Hospital death-rate was 17·2; at St. Mary's Hospital in 1903 it was as high as 30·5 per cent. This goes to show that there has been a much greater rise in the total number of cases of the disease between 1901 and the beginning of the war period than the mortality figures show. There must be quite five times as many cases of the disease recognized to-day as in 1901, when we take into account the rise from 38 to about 70 deaths, and also the marked fall in the death-rate. It is further quite clear that the privations of the later stages of the war period, 1917 and 1918, did not materially alter the incidence of the disease.

Hospital Figures.—A third method of checking the increase is by a careful analysis of hospital figures. Fortunately, the medical and surgical notes of cases at the Bristol Royal Infirmary have been excellently kept for fifty years past, and are a veritable mine of historical information. The Infirmary is the larger of the two general hospitals in Bristol, and drains not only the town but also the surrounding country, especially within a 20-mile radius. There have been no special conditions to alter the complexion of the admissions during the past fifty years, except that a more trivial type of case has steadily given place to a more serious.

The figures are given in the table on next page. It should be carefully observed that they do *not* include interval cases, appendicular colic, appendicular dyspepsia, and the like, but only cases of acute appendicitis with raised pulse-rate and temperature.

It will be noticed that there were a few cases even in 1880: that the great rise took place between 1895, when it was just beginning, and 1905; that since 1905 it has been fairly steady; that there was no drop, but rather an increase, during the years of privation towards the end of the war. This increase, however, may have been accidental. The medical profession sends in a much larger number of early cases now than formerly, and country doctors, who might have operated at home, were away at the war. On the other hand, it must be remembered that a very large number of men, and some women, between 18 and 45, liable to the disease, had been withdrawn from the civilian population.

Now, it may be argued that the increase between 1895 and 1905 does not correspond to a genuine increase of appendicitis in the district, for the following reasons.

1. *That appendicitis may have been seen, but not recognized as such.* It may be argued that Fitz's monograph was not published till 1886; that it might have been several years after that before the medical profession in Bristol realized the importance of the condition, and that the disease was not looked for. Consequently it passed by other names, 'gastritis', 'inflammation of the bowels', and the like.

It is quite certain that this objection is incorrect. I have gone through the 1880 notes, medical, surgical, and gynæcological, with great care. 'Appendicitis' is not once diagnosed, but there are two cases recorded as 'perityphlitis' and one as 'iliac phlegmon.' It is clear, therefore, that the condition *was* recognized, though under the older name. It is quite often mentioned in the notes, in cases of colic, gastritis, etc., that there was "no tenderness in the right iliac fossa". Obviously 'perityphlitis' was being watched for. Further, I have gone carefully over the notes, usually full and excellent, of all the cases with abdominal symptoms, including a large number of patients with typhoid fever, some of peritonitis, diarrhœa, gastritis, colic, etc., and it is impossible to force them into being appendicitis. I allow one probable case, and four barely possible, but no more. All eight recovered; the iliac phlegmon was the only one operated on. In 1885 there are two cases diagnosed as 'peritonitis' which were quite probably appendicitis, and one very doubtful case recorded as 'intestinal colic'. All three recovered without operation. It should be understood that all the figures given, early and late, relate only to acute cases with a raised pulse-rate or temperature.

2. *That appendicitis was common outside the Infirmary, but that no special effort was made, as nowadays, to get the patients in.* At the present time, nearly every doctor in town and country hurries his appendix cases to a hospital, or summons a surgeon, as soon as they are recognized; before 1900, no attempt was made to do this.

Bristol Royal Infirmary Figures.

Year	Number of Cases of Probable or Certain Acute Appendicitis	Additional very Dubious Cases	Total In-patients Treated
1880	4	4	2591
1885	2*	1	3370
1890	4	6	2913
1895	15	—	2910
1900	23	—	2865
1905	64	—	3762
1910	58	—	4149
1915	75	—	3481
1917	98	—	3907
1918	113	—	4021

* Some notes are lost, and an equivalent period of 1886 has been substituted.

Whilst so much must be admitted, it seems certain that appendicitis could not have been anything like as common in the community before 1900 as it is to-day. Quite forty per cent of patients with acute appendicitis not operated on would have a long and serious illness; many would die. Pressure on the Infirmary beds in those days was not severe; plenty of cases of syphilis, colic, bronchitis, and other mild conditions were admitted. Surely a great number of the poorer folk with perforated appendices would have sought admission, if they had existed.

It is easy to put it to the proof. Let us compare the years 1885 and 1915. In 1885 there were two cases of probable appendicitis and one barely possible case; all recovered without operation. In 1915 there were 75 patients with acute appendicitis. Let it be admitted that some of these were early cases who might have got well at home. Let it further be admitted that some of them were drafted in from the country, and that in 1885

this might not have occurred (though plenty of country patients used to be taken in, even then). But eliminating all these, we are left with 34 patients with a *perforated* appendix, drawn entirely from the city of Bristol. Making every allowance for the growth of the population, which was 206,503 in 1881 and 352,859 in 1915, it is quite clear that there must be an enormous rise in the incidence of the disease, because surely a considerable number of these patients, with a perforated appendix and resident in the city, would have resorted to the institution to be nursed through such a serious illness.

3. It may further be objected, *that in the earlier period appendicitis may have been treated more in private practice, but now mainly in hospital.* There is some evidence that the very poor suffer from this disease less than the better fed; before 1900 the poorer classes were ill-fed, and may not have suffered to the same extent.

This objection is more difficult to meet. Several old practitioners to whom I applied had no notes available. I am greatly indebted to Dr. Shingleton Smith, who was honorary physician to the Bristol Royal Infirmary from 1873 to 1905, for the figures of his private practice from 1885 to 1890. It should be explained, to give the record its proper value, that Dr. Shingleton Smith was then one of the busiest and best esteemed physicians in the city, with a good-class practice, and he divided with two or three others nearly all the private consulting work. He was also thoroughly alive to the existence and importance of 'perityphlitis' or 'appendicitis'. At that period such cases more commonly went to a physician than to a surgeon. At the Infirmary in 1885 and 1890 there were ten of these patients in the medical wards, and only three in the surgical.

Dr. Shingleton Smith saw in the five years six cases of possible or probable appendicitis, one of which died, and another was operated on by Mr. Greig Smith. It is not easy to gauge exactly from this what the incidence of the disease was in private practice as compared with the hospitals, but it seems certain that it could not be nearly as common as it is now. The present-day Bristol surgeons undoubtedly see well over a hundred cases a year between them in their private practice, and if the disease had been equally common in 1885, each of the three or four consultants, carrying on a family practice besides, must surely have seen many more than one a year. During the same period Dr. Shingleton Smith saw seven cases of tuberculous peritonitis. At the present time this disease is nothing like so common in Bristol as acute appendicitis. On the other hand, the average general practitioner to-day may not see more than a dozen cases in five years. Perhaps it is fair to conclude that in Bristol thirty-five years ago appendicitis was probably commoner amongst the well-to-do than amongst the hospital classes, but that it was not nearly as common as it is to-day.

THE DISTRIBUTION OF APPENDICITIS IN THE COMMUNITY.

As is well known, appendicitis may attack persons of any age and either sex, and no class in the community is altogether exempt. Occupational statistics do not appear to be available.

It is commonest between the ages of 10 and 30 (large figures analyzed by Kelly), but the Registrar-General's returns show the highest death-rates between 5 and 15, because appendicitis in children is relatively more fatal. It is rare under 3, but does occur; even within the first two months of life a few cases are reported. It is also rare in the aged, but has been seen at 78.

There used to be a marked disparity between the sexes, males being more liable. Many early figures gave the proportion as 3 male to 1 female. Of late years the difference has been less marked. In 1918, 1298 males died of the disease in England and Wales, and 1118 females.

It is quite common to find appendicitis running in families, and, making all allowance for chance and the frequency of the disease, it seems certain that some families have a special liability.

Evidence has already been quoted that the rise in the incidence of appendicitis was later in rural than in urban districts, but to-day there is little if any difference.

A very interesting question, to which only a partial answer can be given as yet, is the relative frequency of appendicitis in the Army and in men of the same age in the civilian population. Most surgeons who have had experience of the disease occurring in large civilian communities, and who also worked with troops during the war at base hospitals or casualty clearing stations, will probably agree that there was no excess of cases in the Army—possibly a smaller proportion than in a civilian population. The Registrar-General's figures for 1917 show: 620 deaths from appendicitis amongst 5½ million civilian males aged 15 to 45; 196 deaths from appendicitis amongst (? 2 million) non-civilian males. One can only guess at the number of members of the Army, Navy, and other forces in this country during 1917; every town and village seemed full of khaki. If it is taken as 1 million, the ratio of civilian deaths from appendicitis per million is to that of non-civilian as 112 to 196. If there were 2 million troops at home, as I think probable, the ratio is 112 to 98. If there were 3 million, the ratio is 112 to 65. Probably, therefore, there were fewer deaths from this disease amongst the troops than amongst civilian males of the same age. Earlier diagnosis and operation in the Army doubtless saved some lives; hence the true incidence is probably much about the same.

There is some evidence that the poorer classes in the community, or at any rate those living in institutions, show a relative immunity. Poor-law patients seldom come to hospital with it. At Portland Prison there was only one case in ten years. I have been impressed by the figures for the past five years of two more or less comparable communities with which I am acquainted. One is a public school with about 500 boys between eight and eighteen. They are liberally fed. There have been 19 cases of appendicitis.

The other is a children's home with an average of 950 inmates over eight (boys 350, girls 600). The larger numbers, and the fact that the home is full all the year round whilst the public school has two months' holiday, more than balance the fact that girls preponderate over boys. The diet consists of bread with margarine, treacle, or dripping, and porridge, daily, with milk; they get tinned meat and potatoes and cabbage on certain days, and fresh meat with vegetables once a week—broth and bread or rice on the other days; fruit, cake, etc., are occasional treats. The general health is excellent. There have been only four cases of appendicitis, all in girls. The disproportion, 19 to 4 in the same period, is very marked.

THE NATIONAL DISTRIBUTION OF APPENDICITIS.

Here we approach a very remarkable aspect of the question. As is well known, appendicitis is very rare amongst Asiatics and Africans, and is only common in highly civilized countries. Unfortunately the available information is still scrappy and disconnected. Much of it we owe to the labours of the late O. T. Williams,[9] of Liverpool.

Appendicitis in Europe.—The available information is as follows:—

Holland.—The death-rate for 1901 to 1904 was 88·8 per million. This would be high for England to-day; it was very high then.

Denmark.—The death-rate in 1914 was given as 12 per million. It is said that the people eat less meat, but more potatoes and rice. Also that they eat less vegetables than in England, but it is not clear what this refers to.

Sweden.—In 1905 the death-rate was 16 per million. The total number of operations throughout Sweden in that year, in hospitals, nursing homes, and private houses, was 2263. The diet included large quantities of potatoes, rye rather than wheaten bread, and much smoked and dried animal food.

Norway.—'Very frequent' amongst the well-to-do.

Spain.—Rather rare. The largest consultant in Madrid (just before 1914) saw only 4 cases in a year. The rich live like the French; the poor live on onions and other vegetables, and a thin stew of poor meat, bread, and rice.

Italy.—There were (about 1912) only about 156 operations a year in Rome for a population of 500,000, which, as Williams remarks, is much less than in Liverpool. In

Bristol there are probably more than twice that number (including interval cases), with a smaller population.

Greece.—Out of 28,000 in-patients, 393 were appendicitis. This is about one-third as many in proportion as we get in Bristol. The poor live on legumes, vegetables, and olive oil, with fish; but very little meat or bread and butter.

Finland.—Krogius[10] gives figures for the hospital at Helsingfors for the years 1901 to 1908. There were 89 cases in 1901, which rose to 237 in 1906, and 193 in 1908. The population is 137,000. The incidence seems rather higher than in Bristol.

Roumania.—Lucas-Championnière[11] in 1904 found only 1 case of appendicitis amongst 22,000 peasant patients, who live mostly on vegetables. The Roumanians living in towns, on a more liberal and meat diet, were frequently affected—1 case of appendicitis per 221 patients.

Appendicitis in America.—

United States.—The disease is exceedingly prevalent, as is well known. The death-rate per million population for 1900 was 97; for 1911 it reached 116. It is relatively much commoner amongst the whites than amongst negroes. Many doctors practising in the 'black belt' of Alabama can scarcely recall a case in a negro. The physician who acted as consultant to the Booker Washington school for 1400 coloured students had not seen a case; but at the Alabama Polytechnic Institute, where there were 400 black boys, there was an annual average of 8 cases. At the former school the diet is simple and the same for all; at the latter the cadets live at different boarding-houses in the town (Kelly).[8] At the Johns Hopkins Hospital, whilst of total admissions black form one-fifth, the number of cases operated on for appendicitis is 12 white to 1 black.

West Indies.—Cleaver states that in Trinidad there are many cases in whites, not one in negroes, though of the population 290,000 are black and only 4000 white. In Jamaica it is very rare in primitive negroes, fairly common in negroes who live in white style (Murray).[12] A missionary from Barbados tells me that in ten years he has never heard of appendicitis in a negro, but frequently in whites, although the population is composed of 12 black to 1 white. Sugar-cane is the staple food of the black; they chew it all the time. Babies are often brought up on sugar and water instead of a proper quantity of milk.

Appendicitis in Asia.—

India.—It is almost absent in villages, fairly often seen in towns (Murray).

China.—Jeffreys and Maxwell[13] state: "The disease is relatively very rare. Reports are to hand from many parts of China on the subject, and all agree that the disease is very uncommon. It is probably a liberal estimate to state that there is not more than one case in 2000 hospital in-patients amongst the Chinese. The disease is, however, frequently seen amongst foreigners." The Chinese live on two meals a day of rice and vegetables. Pork is dear, and meat and fish they seldom get. Diarrhœa and other digestive diseases are common.

Persia.—It is very uncommon in natives, often seen in Europeans. The natives live on wholemeal bread, some meat, rice, and a great deal of fruit, lettuce, cucumber, beet-root, and cheese. Everything is cooked in fat. Reports from sixteen doctors show 57 cases amongst 54,000 patients, and of these 9 or more were Europeans. One old resident said he had seen more appendicitis amongst 100 Europeans than in 200,000 Persians (O. T. Williams).

Appendicitis in Africa.—

Morocco.—A doctor reports only 2 cases in sixteen years, but several in whites (Murray).

Nyassaland.—Four cases in whites, none in 5000 natives.

Central Africa.—Dr. Fisher, of Kalene Hill, who has been nearly thirty years in Africa, tells me he has very seldom seen appendicitis.

Abyssinia.—Dr. Wakeman, M.O. to the British Legation, reports no cases in eight years. The food is a small-grained cereal; they also eat raw beef, mutton, game, and legumes, with much melted butter.

Zanzibar.—Waller[14] states that "acute appendicitis in an African native, if not unknown, is, I believe, exceedingly rare." He narrates a case in a native ayah living on English food.

Egypt.—Dunn[15] saw 2 cases in six years at Luxor. The natives live on fish and vegetables.

Johannesburg.—Appendicitis amongst Rand natives is almost never seen (Pitchford, quoted by Shattock[16]).

Madagascar.—Peake[17] saw only 3 or 4 cases a year in 15,000 to 25,000 patients. The native diet is mainly rice and herbs, with a fair amount of beef and pork.

Appendicitis in Polynesia.—

Solomon Islands.—Crichlow[18] had not seen a case in a native in five years, but a native girl living as a European in an Englishwoman's home got it.

New Guinea.—W. M. Strong reports having seen in ten years one case in a white, one in a native who took to European food, and one in a raw native.

It is very unfortunate that the medical reports issued by the Colonial Office do not record appendicitis under a separate heading. This ought to be remedied.

APPENDICITIS IN ANIMALS.

The disease appears not to occur in animals in the wild state, but it is quite common amongst apes in captivity. At the London Zoo there were two cases in gibbons and one in a chimpanzee, verified at autopsy. There were 15 cases of inflammation in the cæcum or cæcal appendages of various other animals (Murray). Weinberg[19] reports that 10 out of 61 post-mortems on chimpanzees in captivity showed appendicitis.

Some experimental evidence will be referred to later.

SUMMARY.

Let us now gather together the threads of our problem by stating the facts that demand an explanation.

1. Appendicitis was present, but was relatively rare, in this and other countries until the end of the nineteenth century. Since then it has become very common in most highly civilized countries.

2. The rise, in Bristol and probably throughout England, was beginning in 1895, and was pronounced between 1895 and 1905, since when it has been fairly stationary.

3. The rise was more marked, at first, in towns, in the male sex, and, probably, amongst the better-off classes.

4. Inmates of institutions on a somewhat plain diet are relatively immune.

5. The privations of the war did not reduce it.

6. Soldiers were not unduly affected; possibly they were slightly less liable.

7. In spite of gaps in our evidence, it is clear that the national distribution is very unequal. In the United States, Great Britain, probably France and Germany, Holland, and Helsingfors, the incidence is high. In Denmark and Sweden it is lower. In Spain, Greece, Italy, and the rural parts of Roumania it is low.

8. In Asiatics, Africans, and Polynesians it is very rare, unless they take to European food; then it becomes common.

9. In wild animals it is rare or absent. In animals in captivity it is common; this specially applies to apes.

II. THE ULTIMATE CAUSE OF APPENDICITIS.

The medical press has witnessed at times a lively discussion as to the reason for the increase of appendicitis, and all sorts of suggestions, possible and impossible, have been made. It was alleged, for instance, that the use of enamel ware for cooking is responsible; but inasmuch as bits of the ware are seldom if ever found in the appendix, even if a concretion is present, the theory is quite baseless. Someone suggested that the use of

water-closet seats instead of squatting for defæcation is to blame. The late Dr. Charles Mercier was so moved to scorn by the plethora of baseless speculations that he propounded the theory that it was due to the abandonment of wig-wearing—there were no cases recorded from the days of Charles II, when wigs came in, till the end of the eighteenth century, when they went out, except for judges, barristers, and Victorian bishops. He knew of no cases in legal luminaries, and " who ever heard of appendicitis in a wigged bishop ? "

Many are satisfied to regard the disease as the product of " the advances of civilization ". No doubt this statement includes the truth, but all the same it deserves to be vigorously combated. It is vague, largely untrue, quite unscientific, and useless in practice. It is untrue, because civilization as such was *not* new-born in 1895. It is unscientific, because the analogy of other diseases—enteric fever, malaria, scurvy, rickets, and a score besides—shows that the causation of disease is not something vague and diffuse, but definite incidents or habits. It is useless, because we cannot put off our civilization from us. The phrase is a cover for slipshod thinking.

By far the most probable explanation is that the rise in the incidence of appendicitis is due to some change in the food habits of the people. The appendix is part of the alimentary canal, and is therefore directly affected by diet. The period 1890 to 1905 was characterized by an immense increase in the imports of quite a number of foodstuffs into this country, as we shall see, so much so that the national diet must have been greatly altered. Europeans in the tropics retain their liability to the disease. It is highly significant that institution diet does *not* predispose to the disease ; that reports come from the United States, West Indies, Zanzibar, the Solomon Isles, and elsewhere, that natives or Africans taking to European food are liable to the disease, but Africans, Asiatics, Polynesians, and the peasants of Spain, Roumania, and Greece are relatively immune. Countries where the diet is more modern, such as England, Holland, and the United States, suffer more than Italy and Scandinavia. Lastly, apes in captivity share the penalty of civilized food-habits. Our problem, therefore, begins by passing in review the use of the principal foodstuffs, and especially imported foodstuffs, because it is from amongst these that the newer dietary has largely been constructed. The old England used to feed herself ; modern England, as the war has taught us, gets most of her food from overseas.

The principal imported foodstuffs[20] are wheat and other grains, meat, butter, tea, coffee, cocoa, sugar, rice, bananas, oranges, currants, and raisins.

Wheat, Flour, and Grain need not be taken into account as directly giving rise to appendicitis. Such a theory would be incompatible with the facts to be explained. We must, however, notice the suggestion made by Battle[21] that the rise in the incidence of the disease is due to the substitution of iron rollers for the older stone mills to grind flour. He brought forward in evidence six appendices that showed black pigmentation of the mucosa, attributed to deposition of iron dust derived from the rollers, converted by putrefactive gases into ferrous sulphide. Shattock,[16] however, advances chemical proof that the black pigment is not iron. He remarks that if the theory were true that enamel-chips from cooking vessels gave rise to inflammation of the appendix, dust from the old stone rollers should have induced it. In each case the chips or dust would be composed of silica, and be insoluble in the digestive juices. In the Transvaal, where pneumonokoniosis is so prevalent, there is no undue prevalence of appendicitis amongst the white miners, and the natives are practically immune.

The discussion is not without value, as showing how many complicated by-ways of food-production need to be explored to get at the cause of appendicitis.

Butter.—This cannot be the cause. Plenty of butter was eaten in old England before the disease became common. During the later years of the war, very little butter has been available for anybody, but there has been no falling off in appendicitis cases. The consumption per head of imported butter in the United Kingdom is given in the following table. It is charted alongside of the appendicitis curve at the Bristol Royal Infirmary in *Chart I* (*Fig.* 116). The question of chemical preservatives will be considered later.

Tea cannot be accused of causing appendicitis, if only by reason of the immunity of tea-drinking people like the Chinese. The rise in consumption during the critical period is not great. (*See Chart II, Fig.* 117.)

Coffee must be exonerated. The consumption per head in 1890 averaged 0·75 lb. per annum, and in 1914 it had dropped to 0·63.

Cocoa.—It would be possible to make out a case against cocoa and chocolate. There has been a steady and considerable rise in consumption over the period in question, from 0·3 lb. per head in 1880 to 1·2 lb. in 1914. Cocoa and chocolate are a civilized taste, and they are much favoured between the ages of five and thirty. Inmates of institutions would get less chocolate, if not less cocoa. Its use did not lessen during the war ; nor did appendicitis. (*See Chart I, Fig.* 116.) At the same time, it does not seem probable that the key to the problem lies here. The rise in consumption between 1895 and 1905, the critical period, is only from 0·62 lb. to 1·1 lb., which does not seem great enough. There is no apparent reason *why* cocoa, or chocolate apart from its sugar-content, should upset the alimentary canal. It would scarcely explain the prevalence in apes in captivity, unless they are pampered with more chocolate than one would expect.

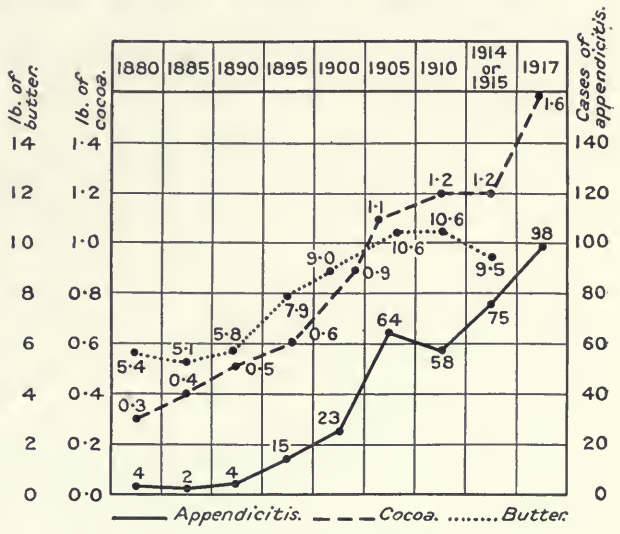

FIG. 116 (CHART I).—Showing (*a*). The average annual consumption of *imported butter*, in pounds per head of population of the United Kingdom ; (*b*). Ditto of cocoa and chocolate, expressed as *raw cocoa imports* ; (*c*). Number of cases of acute appendicitis at the Bristol Royal Infirmary.

Table I.—CONSUMPTION OF IMPORTED BUTTER, COCOA, TEA, AND SUGAR, IN POUNDS PER ANNUM, PER HEAD OF POPULATION.

	IMPORTED BUTTER	RAW COCOA	SUGAR	TEA
1880	(5·4)*	0·30	63·4	4·6
1885	(5·1]*	0·40	74·2	5·0
1890	5·8	0·54	73·2	5·2
1895	7·9	0·62	87·9	5·6
1900	9·0	0·92	87·3	6·0
1905	10·6	1·1	74·4	6·0
1910	10·6	1·2	83·4	6·4
1914	9·5	1·2	95·7	6·9
1917	—	(1·6)†	(63)†	(6·0)†

* The Board of Trade returns include margarine, probably about 2 lb., with butter, given as 7·4 and 7·1.
† My estimates deduced from published figures : only approximate.

Sugar may be dismissed the court. There has been a steady rise in sugar consumption per head during the past forty years, but there was no rise between 1890 and 1905, the critical period ; the consumption fell away to the 1880 figure towards the end of the war ; and, as has been mentioned before, the negroes of Barbados almost live on sugar but do not get appendicitis. (*See Chart II, Fig.* 117.)

Rice cannot be blamed. It is the staple food of the Chinese and many Indian races. There has, however, been a moderate rise in its consumption in this country, from 9 lb. per head in 1890 to 14·6 lb. in 1914.

Bananas.—A banana theory of appendicitis has been put forward and defended by Stephens.[22] He maintains that most civilized countries started to import bananas in great quantities just about the time that the incidence of the disease rose, partly in consequence of a Government subsidy from 1901 onwards. He points in confirmation to the relative immunity of those who are too poor to buy bananas. The suggestion, however, can scarcely be accepted. The main rise was too late to fit the theory, and the great drop in imports during the war has not abated the course of appendicitis. Natives of the West Indies get plenty of bananas but no appendicitis.

Table II.—Imports of Bananas into England and Wales.

Year	Bunches	Year	Bunches
1884	10,000	1910	6,000,000
1900	1,300,000	1914	9,000,000
1905	5,700,000	1917	2,200,000

Oranges.—The number imported has only risen from 3 million to 5 million cwt. since 1895, so this cannot be the effective cause.

Currants and Raisins may safely be exonerated. Consumption has actually fallen, from 4·7 lb. per person in 1890 to 4·5 lb. in 1914.

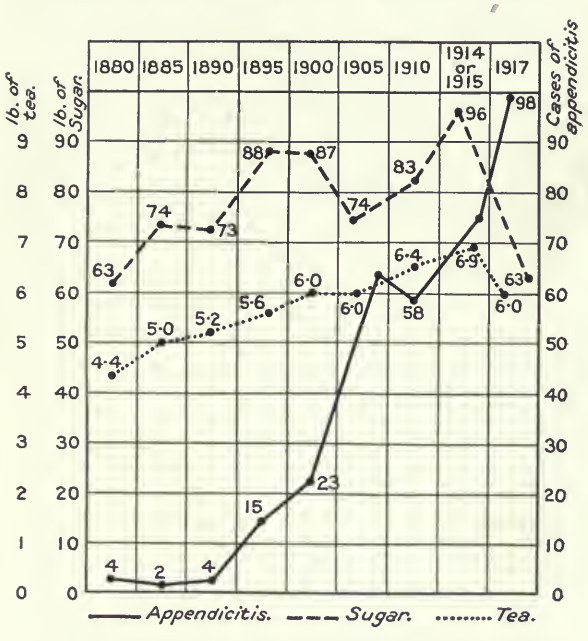

Fig. 117 (Chart II).—Showing (*a*). Annual average consumption of sugar per head of population of United Kingdom, in pounds; (*b*). Ditto of tea; (*c*). Cases of acute appendicitis at the Bristol Royal Infirmary.

Meat.—There is much to be said for the widely accepted view that meat-eating is the cause of appendicitis. The national distribution of the disease is strongly in favour of the theory. In the main, the meat-eating races suffer, and the more or less vegetarian Chinese, Indians, and Africans escape. Southern Europe is less affected than Northern Europe, and less meat is eaten in the southern countries. The Polynesians eat much fish, but not much meat, and they escape. Then again, before 1900 there used to be a very large class in this country who lived in abject poverty, and could not get meat; things have mended very much in this respect during the past twenty years. Dr. O. T. Williams,[9] before his lamented decease at an early age, put together a valuable body of evidence supporting this view, which has already been largely drawn upon. He demonstrated that the appendix mucosa and concretions in cases of appendicitis contain calcium soaps and other insoluble compounds of the saturated fatty acids. This has been confirmed by Bertha Anthony[23] in America. Williams maintains that olein is almost fully absorbed (98 per cent) from the intestine, but that stearin is very imperfectly absorbed (9 to 14 per cent). He believes that the fatty acid compounds may be unabsorbed residue

from saturated fat in the diet, and the principal source of such fat would be meat. He believes that there has been a great increase in the amount of meat eaten in this country, and points to the immense growth of the imports of frozen and tinned beef and mutton. Murray[12] continued the investigation by adding fresh evidence from more or less vegetarian countries where there is very little appendicitis.

One may accept the demonstration that calcium soaps, etc., are present in the chronically inflamed appendix, without necessarily conceding that the fatty acids are derived from non-absorbed fat of meat. It is well known that it is common for chronically inflamed or degenerating tissues to develop considerable quantities of fat in visible form. All the fatty degenerations of pathology are instances of this. If it is the *fat* of meat that is at fault, it is curious that children, who so often dislike meat fat, are principal sufferers from the disease. Also, appendicitis may occur in vegetarians. I have made no special inquiry as to my patients' diet, but I know one was practically a vegetarian.

The crux of the matter, however, turns not on isolated personal experiences or on doubtful points in chemical pathology, but on the larger data furnished by big communities. Was there a great increase of meat-eating between 1895 and 1905? Will the theory explain the distribution of appendicitis?

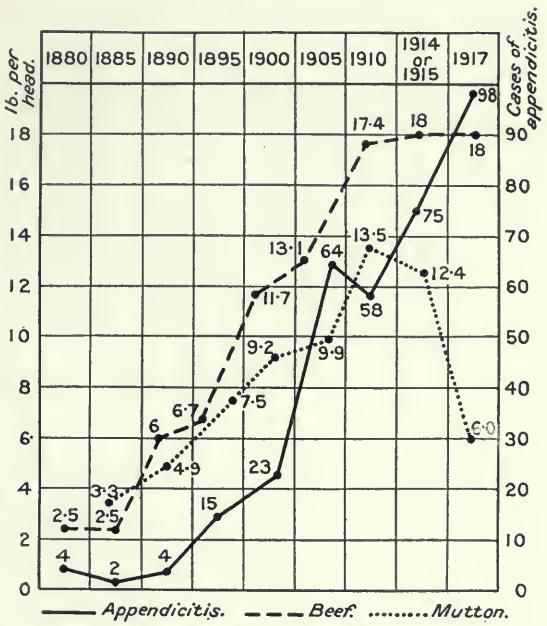

FIG. 118 (CHART III).—Showing (*a*). Average annual consumption of *imported beef* in pounds per head of population of United Kingdom; (*b*). Ditto of *imported mutton*; (*c*). Cases of acute appendicitis at the Bristol Royal Infirmary.

At first sight, the correspondence between meat-consumption and appendicitis seems remarkably close. The parallelism, for instance, between the appendicitis curve and the imported beef curve shown in *Chart III* (*Fig.* 118) is so striking that it would appear that our problem is solved right away, and it must be allowed as practically certain that there is a relation between the two, indirect if not direct. The consumption per head of the population for imported beef rose from 2·5 lb. in 1880 and 1885

Table III.—To show Annual Consumption of Imported Meat per Head of Population, for United Kingdom, in Pounds.

Year	Bacon and Ham	Beef, Salted, Frozen, Fresh, etc.	Mutton, Fresh, Frozen, etc.	Beef from Live Imported Cattle	Mutton from Live Imported Sheep
1880	15·9	(2·5)*	—	(5·8)*	—
1885	11·5	(2·5)*	(3·3)*	(5·8*	(1·0)*
1890	13·5	6·0	4·9	11·1	(0·6)*
1895	14·6	6·7	7·5	8·1	(1·3)*
1900	19·5	11·7	9·2	9·2	(0·6)*
1905	17·4	13·1	9·9	9·5	0·26
1910	11·2	17·4	13·5	3·2	—
1914	14·2	18·0	12·4	—	—
1917	18.0	(18·0)*	(6·0)*	—	—

* Rough figures calculated from published returns.

to 17·4 lb. in 1910, and it doubled in the critical period, 1895 to 1905. The curve for imported mutton is almost as striking, though it shows a big drop in 1917. Expressed in another way, imported beef—frozen, fresh, salted, etc.—rose from 1 million cwt. in 1880 to 2½ million cwt. in 1890, nearly 6 million cwt. in 1905, and 9½ million cwt. in 1914. Mutton rose from 1,734,000 cwt. in 1890 to 3,841,000 cwt. in 1905, and 5,260,000 cwt. in 1914.

This remarkable increase might be directly related to the appendicitis figures in one of two ways; either the *preservation* of the meat may be harmful, or the increase in the total quantity eaten. These must be considered separately.

Table IV.

Year	Population of United Kingdom	Resident Cattle	Resident Sheep	Consumption* per Head of all Imported Meats, Dead or Alive, in lb. per Annum
1880	—	5,900,000	26,600,000	—
1885	36,300,000	6,600,000	26,500,000	24·1
1890	—	6,500,000	27,000,000	36·1
1895	39,200,000	6,300,000	26,000,000	38·2
1900	—	6,800,000	26,000,000	50·2
1905	42,900,000	7,000,000	25,000,000	50·1
1910	—	7,000,000	27,000,000	45·3
1914	46,000,000	7,100,000	24,000,000	44·4
1917	—	—	—	42·0

* My calculation from Board of Trade returns.

Question of Preserved Meat.—Everyone who served in the Army, especially overseas, will agree that a principal difference between Army diet and home diet was the quantity of preserved meat served out to us in the former. Bully beef, veal loaf, frozen beef or mutton, or Maconachie ration was our daily fare, especially the tinned foods. Therefore, if the increase in appendicitis is due to the use of these articles, the Army and Navy should have suffered very badly. But there is no evidence that they did. As far as I am aware, no publications have called attention to any undue prevalence of appendicitis. Personal experience is that the incidence was normal or subnormal. The Registrar-General's mortality figures for non-civilians in 1917 are probably lower than those for the same class of civilian men.

Preserved meat could not be the cause of the prevalence of appendicitis amongst apes. Institution diets contain more of it, relatively, than fresh meat, yet institutions are less liable to the disease.

If it be maintained that it is not tinned but frozen meat that is to be blamed, it becomes difficult to explain the high incidence amongst Europeans in the tropics where there are no public refrigerators to store frozen meat pending distribution.

Question of Increase in Total Meat-eating.—O. T. Williams, Murray, and others have attributed appendicitis, not so much to the use of preserved meat, but to the consumption of a relatively large total quantity of all meats. If this is to be accepted, it must be proved that much more meat is eaten nowadays in England than used to be the case, and that the main rise took place between 1895 and 1905.

Certainly it is true that there was about that time a great development of the trade in imported beef and mutton, frozen, salted, or otherwise preserved. America started sending us meat in 1876 (only 5513 tons), Australia about 1881, and the Argentine in 1889. In 1905 only 21·7 per cent of our meat was home-produced. In 1888 there were only 57 meat-ships; in 1908 there were 190. But this has not been the only source of meat. Three other factors enter into the problem. The first is the importation of live cattle and sheep for slaughter. This trade was considerable before 1890; even in 1875 265,000 cattle and 985,000 sheep were brought in. It rose till 1905, then fell away, and

since 1912 it has practically died out. The second factor is our supply of home-fed beef and mutton. Now for many years past, say since 1885, there has been almost no change in the number of the flocks and herds in this country—about 6½ million cattle and 26 million sheep. It is therefore evident that the home-grown meat supply has remained stationary, whilst the population has risen from 36 million to 46 million. So there has been a drop in consumption. The third factor concerns bacon and ham. Here there have been great annual fluctuations, but on the whole no great change in consumption from 1880 (15·9 lb. per head) to the beginning of the war (14·2 lb. per head).

I have recalculated the consumption per head of all imported meat, dead or alive, including beef, mutton, bacon, and ham. The result is given in *Table IV* and *Chart IV* (*Fig.* 119). There was a rise, truly, from 1885 to 1900; since that time, up to 1914, the high level was scarcely maintained. But the rise in the critical years, 1895 to 1905, was only from 38·2 lb. to 50·1 lb., and in 1917 it fell to 42·0 lb. All this time the consumption of home-grown meat was falling (since it was stationary on a rising population). During 1918 we had severe meat-rationing, nominally 12 oz. per week, but this did not check appendicitis, although it seems certain that the civilian population in 1918 got less meat than in 1895.

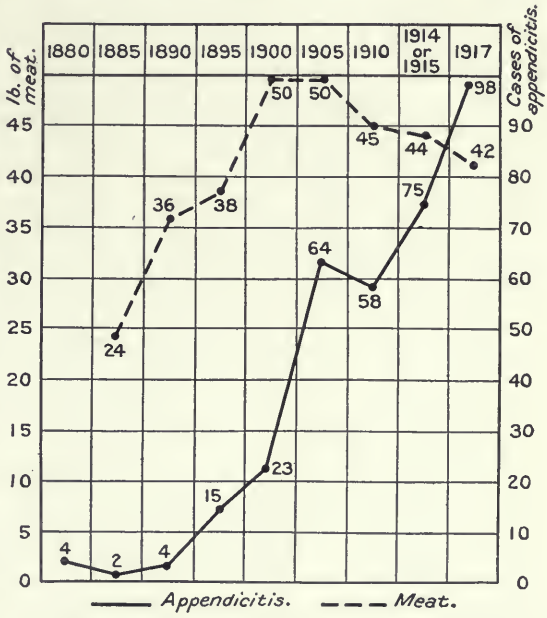

FIG. 119 (CHART IV).—Showing (*a*). Average annual consumption of all forms of imported meat in pounds per head of population of United Kingdom; (*b*). Cases of acute appendicitis at Bristol Royal Infirmary.

But the problem may be considered from another point of view. Admitting that thirty years ago many people got very little meat, there was even then, and always has been, a large minority of farmer families, well-to-do folk, soldiers, and others who got quite as much as the same classes do now. Our old songs sang the praises of the "Roast Beef of Old England", and contemporary records tell us of gluttonous feasts. In 1889 the official ration for soldiers in the British Army included 12 oz. of meat daily, and 1 lb. of bread. Brigade-Surgeon Maunsell[24] weighed 1232 rations, and found that the average amount of cooked meat issued, exclusive of bone and dripping, was 7 oz. 1 drachm daily per man. In a report to Parliament, also in 1889, the manager of Pearce's Dining-rooms showed that the firm fed 30,000 carmen daily, and that they consumed daily for dinner 5 oz. of meat, weighed uncooked without bone. Clearly, there were millions of people in England eating as much meat as anyone does to-day, and far more than civilians could get in 1918. If meat-eating were the cause of appendicitis, there should have been quite enough before 1890 to make it a common disease, and it should have almost died out in 1918.

Meat-eating will not explain the incidence of appendicitis in captive apes. When the national distribution of the disease is studied, it will be seen that races who are almost immune vary very much in the amount of meat they eat. In Persia, Abyssinia, and Madagascar they apparently take a fair amount.

The Question of Dental Caries or Nasal Sinusitis.—It has been maintained that carious teeth, or suppuration of the accessory sinuses of the nose, may be responsible for appendicitis. Neither of these can be taken seriously until it is shown, which is unlikely to be the case, that there was a marked rise in the occurrence of these ailments between

1895 and 1905, and even then we should have to trace the cause of that rise. It is not denied, however, that sinusitis, like tonsillitis, may be the proximate cause of an attack.

The Question of Food Preservatives.—The extensive use of boracic acid and other antiseptics as preservatives for foods began about the year 1880, though of course they had been employed to some extent previously. A good deal of attention was paid to the subject between the years 1896 and 1901, and a Departmental Committee appointed in 1899 reported in 1901.[26] They found that these articles were very largely used in milk, cream, butter, margarine, ham, bacon, and pork pies. Analysis showed that 18 per cent samples of milk, and 57 per cent samples of butter, contained them, boric acid being far more used than any other. The figures are available for Birmingham for four years, 1896 to 1900, but there is no great variation. Much more boric acid was used in summer than in winter.

Shortly after the report was published, the amount of preservatives allowed in butter and cream was regulated by the Local Government Board, and its use in milk prohibited altogether. I am informed by a leading dairy expert that during the past ten years very little boric acid or other antiseptic has been used in milk or butter, but that it is still present in bacon. In Denmark its use in foodstuffs was prohibited entirely. There is not sufficient evidence to show whether boric acid can be blamed for the increase in appendicitis. I think not, for the following reasons :—

1. The preservative came into extensive use too early, 1880 to 1895.

2. Children under five take most milk, and therefore should suffer most, but appendicitis does not become common till after that age.

3. There has been no fall in appendicitis corresponding to the lessened use of boric acid of late years in milk. Appendicitis has multiplied fivefold between 1901 and to-day, but there has been little if any increase in boric acid contamination.

4. The disease is common in the farming community, in Europeans in the tropics, and in Denmark, although in each of these little if any boric acid would probably be taken.

What, then, is the Ultimate Cause of Appendicitis ? There was a time when every disease in which diet played a part was thought to be due to something the patient had taken—dyspepsia, typhoid fever (milk-borne), gout (after a public dinner), ptomaine poisoning, asthma, and the like. Recently we have become aware of diseases due not to an excess but to a deficiency. One may instance scurvy, rickets, beri-beri, pellagra, and tetany. As we have failed to find irrefutable evidence that appendicitis is due to an excess of any one article, shall we explore the possibility that it is a deficiency disease ?

Our tables have clearly demonstrated that during the past thirty years, and especially between 1890 and 1905, the dietary of England underwent a radical change by the importation of greatly increased quantities, not of one foodstuff but of many. Preserved meats, butter, tea, cocoa and chocolate, rice and bananas, have all gone up. The importation of wheat rose immensely at the same time—60 million cwt. in 1890 and 97 million cwt. in 1905. Potatoes rose from about 2 million cwt. in 1890 to 3½ million cwt. in 1905. What does all this mean ? It means, infallibly, that older home-grown foodstuffs have been more or less crowded out by the newer, more tasty, or more nourishing imported articles. Swedes, turnips, carrots, parsnips, leeks, asparagus, cabbage of various sorts, rhubarb, lettuce, celery, the coarser fruits and vegetables, oatmeal porridge, rye, barley or other flours—in a word, the cellulose-containing foods—have been replaced in the dietary. It is not necessary to prove that the average Britisher eats less, absolutely, of any or all of these than did his forefathers. That is probably true—I think there has been a marked falling off in the consumption of cellulose—but it would be difficult to prove. The point is, that *relatively to the total food eaten*, cellulose-consumption has fallen, and this has been mathematically demonstrated by the figures given, showing a rise in the personal use of meat, rice, cocoa, chocolate, sugar, and the rest. The consumption of wheaten flour in bread, and especially in cakes and pastry, has also risen, so has that of potatoes. Modern

white bread contains less cellulose than the older browner breads. If a man took porridge for breakfast; soup, turnips, cabbage, and potatoes for dinner; and brown bread and butter and lettuce for tea in 1890, the bulk of cellulose in his total food has been reduced if he now adds bacon, Australian meat, and cakes to his meals, even if he does not drop out the porridge, greens, brown bread, and lettuce.

Let us see how this theory will fit our facts.

1. The time-criterion is correct. It was between 1895 and 1905 that the great dilution occurred, and then appendicitis had its increase. Since then the dilution and the increase have both been much less marked.

2. The cellulose foods would be in favour longer in the country than the town, but nowadays country diet and town diet are much alike. The appendicitis rise began in the towns.

3. In institutions, the older, simpler, and cheaper foods are still used, and are less diluted.

4. Apes in captivity do not get the coarse fibrous foods they did in the wild state.

5. During the later stages of the war, in spite of various privations, there was no great return to the old coarse foods. People ate less, but of the foods they were accustomed to. Soldiers got 'pork and beans', Maconachie ration, and often fresh vegetables to protect them.

6. The national distribution of appendicitis is much in favour of the theory. Almost every report from countries where the disease is seldom seen amongst natives lays emphasis on the fact that they partake largely of vegetables and other cellulose-containing foods. When individuals take up European habits, they drop their coarser articles of diet.

7. There is some direct experimental evidence on the subject. Von Knierien[25] showed in 1885 that rabbits fed on a cellulose-free diet develop inflammation of the intestines, and especially of the cæcum, which may be fatal. This does not occur in carnivores, whose cæcum is usually small. Apparently the effect is mechanical, because horn-shavings suffice to avert the trouble. Cellulose, of course, is mainly unaffected by the digestive processes.

It is of course possible that some 'vitamines', so-called, may be bound up with the cellulose. McCarrison[27] showed that autoclaving their food produced in monkeys marked distention and congestion of the intestines, colitis, loss of lymphoid tissue, and invasion of the mucosa by bacteria.

The following table, from Bunge,[28] gives the cellulose content of some foodstuffs :—

Table V.—Percentage of Cellulose in Some Dried Foods.

Wheat Flour .. 0·4	Spinach .. .. 8·1	Asparagus 17
Rice .. .. .. 0·7	Green Peas .. .. 8·7	Cabbage 18
Wheat .. .. 2·9	Carrots .. .. 8·8	Strawberries 19
Potato .. .. 3·1	Apples 10	Melon 22
Lentils .. .. .. 4·1	Radish 12	Pears 25
Beans .. .. .. 4·1	Cauliflower 13	Raspberries 47
Onion .. .. .. 5·0	Cucumber 14	

III. THE PROXIMATE CAUSES OF APPENDICITIS.

Whatever may be the underlying cause, new in the history of medicine, which during the past twenty-five years has been making the appendicular mucosa of civilized people more prone to inflammation, we have further to inquire, granted such a predisposition, what may bring on an individual attack.

1. **Relation to Other Diseases.**—At a large public school in Bristol, there has been noticed over a great number of years a remarkable seasonal association of one or two cases of appendicitis with epidemics of feverish colds and attacks of pharyngitis or tonsillitis popularly called 'influenza', but probably not the same as true pandemic influenza. Krogius[10] comments on the same association in Helsingfors. True pandemic influenza does not seem to act in the same way. There was no special outcrop of appendicitis in

Bristol after the terrible visitations of 1918, and I have only come across one record of any such sequel, described by Hall and Dyas.[29] They report that, after the influenza had visited a soldiers' camp in the States, the incidence of appendicitis rose from 10 per 1000 annually, its previous rate, to 44 per 1000. The outbreak lasted two months. Only one-third of the victims had suffered from influenza themselves.

Dr. Fortescue-Brickdale has kindly prepared for me a table showing the epidemic incidence of measles, mumps, and the other zymotic diseases in the above public school, but there is no relation to appendicitis.

Poynton and Paine[30] found streptodiplococci, apparently identical, in the tonsils and appendix of a case of acute appendicitis, and inoculation of a culture into rabbits produced appendicitis as well as arthritis in one-sixth of the inoculated animals. Adrian[31] in 1901 abstracted a good deal of German research showing that appendicitis may be produced in animals by injecting various organisms, such as strepto- or staphylococci or *B. coli*, subcutaneously.

We conclude, therefore, that throat infections may light up a latent appendicitis into activity.

Constipation, diarrhœa, and other digestive troubles do not, *per se*, cause appendicitis. For instance, they are very common amongst the Chinese.

2. **Trauma.**—There are plenty of cases in the literature in which a blow has started an acute attack. I have seen two such incidents. But there is no doubt that these constitute the rare exception, not the rule. Seeing how prone patients are to recollect, if not to invent, *some* tangible cause for every illness, it is evident that injury plays little if any part in 99 per cent of the cases.

3. **Foreign Bodies.**—If *Oxyuris* is excepted, a foreign body is not found more frequently than in one case in a thousand. In actinomycotic appendicitis they are common.

4. **Oxyuris.**—*Oxyuris* 'appendicitis' is quite common. I have operated on a dozen cases in the last five years. They present an ordinary picture of febrile appendicitis, vomiting is often prominent, but the tenderness over McBurney's point is apt to be rather vague and indefinite. When the appendix is opened, its mucosa is not reddened, and three or four worms are usually to be seen actively wriggling about.

5. **Concretions.**—These are present in 15 to 20 per cent of cases of appendicitis, and 10 per cent of apparently normal appendices (Ribbert). Other figures are those of Krogius—concretions present in 35 per cent of cases of diffuse peritonitis, 27 per cent of patients operated on in the pre-perforation stage, and 12 per cent interval operations. My own experience would suggest that these figures are rather high.

The concretion is formed *in situ*, from a mixture into which dried fæces, calcareous secretions from the mucosa, and possibly, as Williams suggested, unabsorbed fat residues, all may enter. Probably the presence of a true concretion (not of a nodule of fæces), proves that the mucosa is not normal. Concretions play a very important part in determining an acute attack. There is often a very characteristic history of pain without fever for a day or two, due to appendicular colic, then fever from inflammation of the mucosa distal to the obstruction, owing to lack of drainage, then a day later, or less, sudden cessation of pain from perforation, followed by the signs of localized peritonitis.

6. **Kinks.**—Adhesions or kinks obstructing the appendix often induce an acute attack.

7. **Relation to Chronic Intestinal Stasis.**—This is too large a subject to deal with here. Suffice it to say that there is a relation between this condition and appendicitis. I operated two days ago on a college boy with a first attack of acute appendicitis. The appendix was lying outside the cæcum pointing upwards, and was extensively caught up in its whole length in a Jackson's pericolic membrane, just as in Sir Arbuthnot Lane's pictures. The cæcum was large, mobile, and distended.

8. **Menstruation.**—Occasionally the advent of the monthly period precipitates an acute attack.

9. In the majority of cases, however, no definite cause is discoverable why an attack should come on at a particular time. There is no doubt that the stirring up of peristalsis by the injudicious administrations of a purgative has often converted a mild attack into a severe one by inducing perforation.

SUMMARY.

1. There has been a real increase in the frequency of appendicitis in Great Britain and other civilized countries, especially during the period 1895 to 1905.

2. Neither increased meat-eating nor any other addition to the food-supply seems to account for all the facts. It is suggested that the cause is the relatively less quantity of cellulose eaten on account of the wider use of imported foods.

ADDENDUM.

There are a few uncivilized countries where the diet is peculiar, and the natives live principally on meat. Particular interest attaches to the incidence of appendicitis under these circumstances. Unfortunately the available information is only enough to make one anxious for more.

Paraguay.—The inhabitants are practically in a semi-savage state in the Chaco, away from the towns. They are of mixed Indian and Spanish descent. The diet consists of beef three times a day, a species of potato, probably almost free from cellulose, and maté, which is a sort of tea. They seldom get anything else. I am informed by an unqualified practitioner who has spent ten years in the country that appendicitis is quite common.

Labrador.—Dr. Hutton writes me as follows: "I spent seven years among the Eskimos of Labrador, 1903–8, 1911–13, and was in close touch with the health conditions of the thousand or so of natives who are scattered in villages along the northernmost five or six hundred miles of coast-line. The Eskimos of N. Labrador are flesh-eaters, taking most of their food raw—fresh, frozen, or dried. They also boil their food occasionally. The staple foods are seal, cod-fish, and sea-trout: other occasional foods are deer-meat, walrus, white whale, ptarmigan, hares, bears, foxes, seabirds (and their eggs), rock cod, sculpins, and sea-urchins. Vegetable foods are very scanty, limited to berries (*Empetrum nigrum*) in the autumn, and shoots and buds (*Sedum roseum* and *Salix argyrocarpa*) in the spring. The Eskimos add no salt to their food. With the touch of civilization the use of flour and ship's biscuit has become general, especially on hunting expeditions, and to eke out in times of scarcity; tea is freely taken, sweetened with molasses. The pure Eskimos are teetotalers, and heavy smokers.

Appendicitis must be very rare: I know of no case among the primitive raw-flesh-eating Eskimos. During my seven years I only saw one case in an Eskimo, and that was in a young man whose dietary had been a mixture of native and semi-European foods, such as salt pork, salt fish, bread and biscuit."

Unfortunately a population of only 1000, and that scattered over five hundred miles of coast, is scarcely large enough to furnish much indication as to the frequency of appendicitis as compared with such a community as an English town. In the Bristol district a population of say half a million yields perhaps 500 cases a year, which represents an incidence of 1 case per 1000 head of population annually. A doctor dealing with 1000 potential patients would therefore see 7 cases in seven years. Probably the Eskimos over a five-hundred-mile coastline might not be as ready and able to see a doctor as in an English town. It is difficult, therefore, to estimate the real frequency of appendicitis in Labrador. It is interesting that one case was seen, but evidently it is less common than in such a town as Bristol.

It has been suggested to me that a possible cause of the increased frequency of appendicitis in civilized countries is to be found in the widespread use of cheap Japanese

tooth-brushes, which have flooded the market since 1895 to 1900, and which are very apt to part with their bristles. Once again the theory helps us to understand how many different avenues have to be explored before a settled conclusion can be arrived at. Bristles are, however, so seldom met with in inflamed appendices that the suggestion is not likely to be true.

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SEX AND AGE INCIDENCE IN APPENDICITIS.

By A. ERNEST MAYLARD, Glasgow.

With the object of ascertaining the relative frequency of appendicitis in the two sexes and at the various periods of life, I have taken one thousand consecutive cases admitted to my male and female surgical wards in the Victoria Infirmary. These cases practically cover the last ten years, and therefore extend over a period which may be regarded as fairly representative of our present knowledge of the disease in all its varied aspects.

The accompanying charts (*Fig.* 120) have been constructed to present graphically the respective sex and age of the patients. They embrace all phases of the disease, whether acute, subacute, chronic, or intermittent.

It will be noted in the first place, that, so far as the frequency of occurrence in the two sexes is concerned, there is practically no difference; for there were 488 cases in the male, and 512 in the female, a difference of 24 only. In the second place, the ages at which the disease is most frequent also shows a remarkable similarity. For, if the two decades of 10 years to 20, and 20 to 30 are combined, in each instance the total number of males attacked between the ages of 10 and 30 is 330, and of females 363—an excess of only 33. At all the other periods of life there is very little difference between the two sexes.

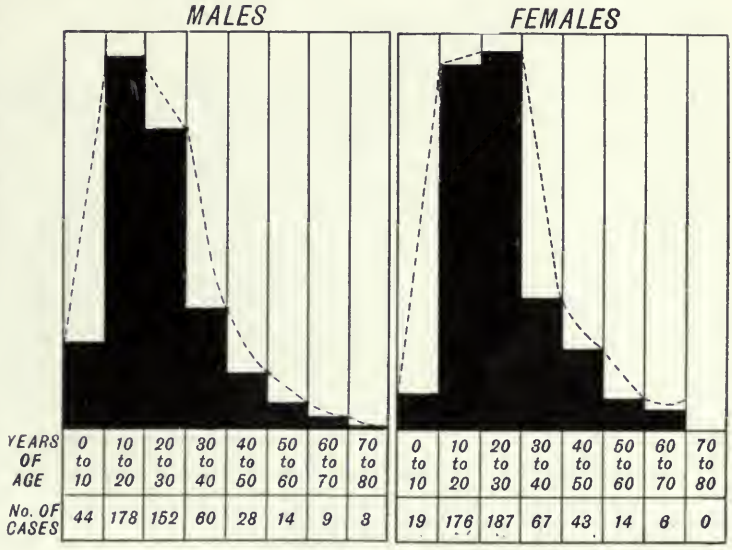

Fig. 120.

As regards the periods of life in which the incidence of the disease is greatest, it will be seen that by far the largest number is in the second and third decades. There is a very sharp rise after the first decade, and an equally rapid decline after the third, to be followed by a more gradual diminution in the succeeding decades.

The youngest patients were four male children, each between 3 and 4 years of age. In each of these there were *B. coli* abscesses. In two, there were stercoliths; in the third, the appendix was gangrenous; in the fourth, there was an ulcer which had perforated.

The oldest patients in the eighth decade were three males two of 73 years, and one of 71. In the former two patients, one was a chronic case in which there had been three previous attacks; the other had a *B. coli* abscess with an appendical stercolith. In the patient of 71 years the appendix was gangrenous. It is of interest, therefore, to note that, from the earliest periods of life to the latest, there is practically no difference in the pathological lesion to be encountered.

TRAUMATIC DISLOCATION OF THE KNEE-JOINT.

By HARRY PLATT, Manchester.

Within the last few years the numerous cases of injuries of the crucial ligaments of the knee-joint sustained under the conditions of military service have afforded a surgical problem which has quite eclipsed in interest and economic importance that of the commoner forms of knee-joint derangement. The instability of the joint characteristic of the crucial ligament rupture is a very serious handicap, judged from the standard of activity expected from a young man, either industrial or athletic. The individual concerned must either contemplate the life-long wearing of an adequate knee brace and often a career of comparative inactivity, or may elect to undergo some form of operative treatment in

Fig 121.—J. E. Dislocation of the knee-joint.
(*Ancoats Hospital Radiographic Dept., Dr. W. J. S. Bythell.*)

which a reinforcement or replacement of the injured ligament is the essential feature. The ingenious operations of Hey Groves[1] and Alwyn Smith[2] at the present time represent the acme of achievement in dealing with this type of disability. But even to-day it must be admitted that these reconstructive operations are still on trial, and for many reasons can hardly be included in the *répertoire* of the average surgeon. It is, therefore, still essential to emphasize the importance of the prevention, if possible, of those untoward mechanical results which are seen to follow rupture, complete or incomplete, of one or

both crucial ligaments. This implies the early recognition of these lesions, and particularly of the slighter grades of injury which often may be associated with the better-known semilunar cartilage and internal lateral ligament injuries.

The gravest type of crucial ligament injury is that which accompanies a complete dislocation of the knee-joint. Two examples of this rare dislocation came under my immediate care in 1915 and 1916 respectively. The functional result obtained in the second case has been so striking as to warrant comment.

Description of Case.—In April, 1916, a man, age 47, was admitted to the Ancoats Hospital twenty minutes after sustaining a fall from the top of a ladder. His headlong descent was arrested by a plank close to the foot of the ladder so that the full brunt of his fall was borne by his left knee, the mesial aspect of which encountered the plank with tremendous force. When examined on admission, the clinical signs rendered the diagnosis of complete dislocation of the knee-joint obvious, and a radiogram, taken before reduction was attempted, provided a graphic record of this unusual type of knee-joint injury (*Fig.* 121). It was noteworthy that there was very little effusion in and around the joint, and there was no sign of vascular obstruction in the lower leg. Reduction of the dislocation under anæsthesia presented no difficulties.

After a stay of seven days the man left hospital with the knee immobilized in a plaster cast. He reported from time to time in my out-patient department, and at the end of four months the cast was removed and a Thomas caliper splint substituted. For some little time before removal of the plaster the patient had been walking on the limb with comfort. Seven months from the time of the accident the man returned to work, having worn the caliper splint for six weeks only; after a period on light duties he finally resumed his old employment as a general labourer. When the knee-joint was examined after removal of the plaster, it was found to be quite stable, and showed great restriction of movement, a range of not more than five degrees active and passive flexion being possible. During the following six months the range of mobility showed a gradual increase, so that eleven months from the time of the accident the joint, painless as before, allowed twenty degrees flexion. Beyond this point there appeared to be very firm resistance. The joint stability remained unimpaired, and it was impossible to elicit any sign of crucial-ligament laxity. The patient expressed himself as satisfied with this as a permanent result. It was now considered that a further increase in the range of movement was unlikely to take place, and this opinion was expressed by the writer in a previous communication.[3]

FIG. 122.—J. E. Showing the range of flexion four years after complete dislocation of the knee-joint.

In May, 1920, the patient visited my out-patient department and informed me that he had served for two years in the army, and that, during the whole of this period, his knee had in no way incapacitated him. On demobilization he had returned to his original occupation, and declared himself still capable of performing the heaviest type of labouring work. The knee-joint now (four years after the accident) shows a range of flexion to just beyond the right angle (*Fig.* 122); in other respects the joint is normal; to all tests its stability is perfect.

Results as felicitous as the above have been recorded after knee-joint dislocations by Sir Robert Jones[4], who has emphasized the one essential feature in the after-treatment, viz., the continuation of immobilization for a considerable period. It is obvious that this principle is equally applicable to all grades of crucial-ligament rupture where the dramatic accompaniment of a dislocation is wanting. An inquiry into the histories of patients who present themselves with the typical unstable knees due to crucial-ligament injuries, almost invariably brings to light the striking fact that, immediately following the trauma, a very short period of complete fixation was maintained, and that this was not followed by a period of deliberate restriction of the range of mobility. If it is possible to ensure a stable knee-joint after the occurrence of a dislocation, it should be at least equally easy to obtain stability after less severe injuries of the crucial ligaments. Given an established diagnosis from the outset, it is far better to aim for stability at the expense of mobility. When all the tests demonstrate that sound healing of the ruptured ligaments has taken place, any residual limitation of joint mobility can be dealt with by the usual measures.

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AN INVESTIGATION OF THE CAUSE OF DEATH IN CERTAIN CASES OF EARLY FATALITY SEEN AT A CASUALTY CLEARING STATION.

By Captain H. W. KAYE, R.A.M.C.

These notes give a brief résumé of certain points of pathological importance that have been observed at various autopsies which were made in order to ascertain the cause of death in each case, and so to throw light upon future questions of diagnosis and treatment. The casualty clearing station in France, at which this work was performed, was situated at a distance of less than ten miles from the front. It therefore received casualties with very severe wounds which, in the worst cases, might be fatal within the first twenty-four hours after their infliction. It is for the latter reason especially that the facts recorded in these notes are of interest, because the lesions which prove fatal at this early time present a different appearance from those that have been described elsewhere in pathological observations made on wounds that proved fatal at a later date.

WOUNDS OF THE CHEST ONLY.

The cases examined were 14 in number, 3 having been caused by high-velocity bullets, and the remaining 11 either by shell-fragments or shrapnel.

The cases fall into two main groups, namely :—

1. Ten who died within twenty-four hours after the wound from the immediate effects of the injury.

2. Four who survived this stage, but succumbed to later septic complications on the fifth, ninth, and twelfth days.

A hæmothorax was found in each of the 14 cases, and in no one of those who died in the first twenty-four hours was there evidence of the presence of air together with the blood in the pleural cavity. The blood in these early cases (*Group* 1) was fluid, and practically free from clot. Its quantity varied greatly; but the lower measurements are of little value, because they were often spoiled by the free leakage of fluid through the external wound in the chest. The maximum volume found on one side was $4\frac{3}{4}$ pints; from 1 to 2 pints was found in several cases.

The lung was found to be wounded in 12 out of the entire 14 cases; but the type of this wound varied in proportion as the chest wall was more or less lacerated by the entering missile. When the entry wound in the chest wall was a tiny track through an intercostal space, a similar track through the lung substance would be found; but even in these simplest of wounds, the lung around this narrow lumen was found to have been infiltrated with clotted blood over an area of about one inch in diameter. With severer wounds that had caused comminuted fractures of the ribs, the subjacent lung was found to present an irregular lacerated wound, often containing splintered portions of rib, clothing, and dirt, while the whole of the wounded lobe was infiltrated with extravasated blood, and looked and felt firm and solid.

There were 3 cases of bilateral hæmothorax, and in each of these the missile (in 1 case a bullet and in the 2 other cases a piece of shell) had passed through the bodies of the 7th, 8th, or 9th thoracic vertebræ without causing any injury to the spinal canal, and without producing any clinical phenomena indicative of damage to the cord.

Septic Hæmothorax.—The outstanding feature of all the four cases in *Group* 2 was the large size of the empyema cavity, which was practically coterminous with that of the pleural

sac. The infection was apparently free to spread in every direction, as it was not limited by earlier adhesions, but only by the reflexions of the pleura. Thus a very large abscess cavity and surface for absorption is formed, which is doubtless the factor which makes the prognosis in this condition serious, although the absence of earlier adhesions must facilitate the establishment of free drainage surgically. The case of a man who died on the fifth day from infection of a hæmothorax with gas-forming organisms is worth quoting in detail.

Case 1.—The patient was admitted with a shell wound of the left side of the chest, and in extremely bad condition—much collapsed and very dyspnœic: pulse-rate 140, respirations 56, and temperature 102°. After two days he had improved slightly. On the fourth day some of the hæmothorax blood was drawn off in the hope of giving relief. This blood was offensive, and was found to contain a large Gram-positive bacillus which was identified with *B. perfringens*. The patient was so ill that it was impossible to attempt surgical drainage of the pleural cavity, and he died the following day. At the autopsy, gas under pressure was found in the left pleural cavity, and the lung was completely collapsed against the vertebral column, being reduced to an airless mass about the size of a fist. The pleura contained two and a half pints of brownish-tinged, most offensive blood, in which there were a few flocculi but no clots. The surfaces of the lung and parietal pleura were covered with soft shreddy fibrin, enmeshing bubbles of gas which gave it the general appearance of a mass of frog's spawn. A fragment of shell covered with khaki cloth was found with some spicules of bone in the upper lobe of the atelectatic lung, which it had entered through the third and fourth ribs posteriorly.

WOUNDS OF CHEST AND ABDOMEN COMBINED.

The cases examined were 22 in number, 6 having been caused by bullets, and 16 by shell and bomb fragments. A hæmothorax resulted in 20 out of the 22 cases. The remaining 2 showed a plastic pleurisy at the base of the lung, but no evidence of a hæmothorax. In each of these last two cases the missile had entered the left side of the chest low down posteriorly, and had perforated the lowest part of the pleural cavity in the immediate neighbourhood of the costodiaphragmatic reflection of the pleura, so that they could hardly be regarded as chest wounds.

In only 6 out of the 20 hæmothorax cases could wounds of the lung be found, and in three of the six the thin free margin of a lobe had been only just touched by the missile. Of the 14 in which the lung was not wounded, 4 presented a small localized bruise, while in the remainder no abnormality could be found beyond a varying degree of collapse.

The hæmothorax in this series of cases must therefore have been derived either from bleeding viscera in the abdomen, or from injured vessels in the chest wall. If it came from the abdomen, a natural assumption would be that such a hæmothorax would be more frequent on the side of the liver. Yet in this group of 20 cases the collection of blood occurred on the left side in 11, and on the right in only 6 examples, while it was bilateral in the remaining 3.

The frequency of the occurrence of a traumatic hæmothorax without any wound of the lung in this last group of abdominal cases therefore suggests strongly that in the majority of examples it is the chest wall which is the source of bleeding. It should be noted that even in the cases in which the lung had been wounded, the extravasated blood within and around the wound was seen to form a firmly-clotted mass within twenty-four hours of the infliction of the wound, so that it is at any rate improbable that prolonged hæmorrhage can continue from this source. On the other hand it was observed that, taking all the 36 cases together, namely those with wounds of the chest only and those of chest and abdomen combined, the missile in entering the chest had caused no fracture of the ribs in 11 cases. A fracture of one or more ribs was seen in 25 cases. It is, however, difficult to draw a clear conclusion from these latter figures, because rib fracture was generally associated with laceration of the lung, and each of the two possible sources of hæmorrhage was therefore fully developed.

For purposes of description the 22 cases in the group of combined abdominal and chest wounds may be divided as follows :—

1. Fourteen who died from the initial lesion (9 within twenty-four hours, and 5 within three days).

2. Six who underwent operation for abdominal injury.

3. Two who died from the rapid development of septic complications.

1. Of the 14 cases, 8 presented a wound of the kidney, 8 of the liver, 6 of the spleen, 1 of the stomach, 1 of the transverse colon, and 5 of the bodies of the dorsal or lumbar vertebræ without injury to the spinal canal. The wounds of these organs occurred in various combinations, the most frequent being a wound of the liver together with a wound of a kidney or the spleen. Some degree of retroperitoneal or intraperitoneal hæmorrhage was found in most of them, but in no case was there a large amount of blood extravasated below the diaphragm. The cause of death appeared in general to be that of shock together with combined hæmorrhage into the thorax and abdomen.

2. A case may be quoted under this heading to show how extensive these combined injuries may be, and how hopeless is the nature of the work that may confront a surgeon when he attempts to save life by operation on a man whose outward appearance may not suggest that his condition is in any way more desperate than that of others in whom the surgical repair of internal wounds has been performed with brilliantly successful results.

Case 2.—Laparotomy was performed, a wound on the anterior surface of the pylorus and three lacerations in the jejunum being discovered. The bullet was lying loose in the lumen of the bowel. The wounds were rapidly sutured, but the patient died four hours later.

It was then found that the bullet had perforated the upper lobe of the left lung, and passed in and out of the posterior wall of the pericardium, where it had made a wound $\frac{3}{4}$ in. long in the left auriculoventricular wall of the heart and half-way through its thickness, so that in addition to a hæmothorax there was distention of the pericardium with blood and air, which entered freely from the pleural cavity. The bullet had then passed on to the abdomen and had caused, in addition to the wounds revealed by operation, an in-and-out wound of the right half of the extra-peritoneal surface of the transverse colon, and a perforating wound of the posterior aspect of the pylorus.

3. One of these cases was a striking illustration of the rapidity with which an infection by gas-forming organisms may spread and cause death.

Case 3.—Admitted three hours after he had received a shell wound of the right arm and chest. His condition was then good, with a pulse-rate of 110, and this state continued for the first twelve hours after infliction of the wound. An hour later he had passed rapidly into a condition of extreme danger, being pale, sweating, and without radial pulse. He died just within twenty-four hours of the wound, with much swelling and discoloration of the chest wall, neck, head, and scrotum.

It was then found that a small shell fragment had passed through the muscles of the right arm, where the wound was perfectly clean, and entered the right side of the chest through the 9th space in the posterior axillary line. A hæmothorax was present, though the lung was not wounded. The missile had then passed through the diaphragm, right lobe of the liver, and upper pole of the right kidney, and had buried itself in the lumbar muscles. The liver (examined two hours after death) was so distended with bubbles of gas that it floated in water. Gas bubbles were also found in the substance of the spleen and throughout the right kidney. The discoloured subcutaneous tissues and a large retroperitoneal hæmorrhage in the right loin were all crackling and full of gas.

PLEURAL ADHESIONS.

A somewhat surprising fact was noticed in regard to the frequency with which old pleural adhesions were found at autopsies upon all subjects. The majority of these examinations were made for wounds received in battle or for acute disease in men who previously had not been in any way disabled for active service. Yet, in a series of 104 consecutive autopsies, old pleural adhesions were found in 34 of the cases. These adhesions varied widely in degree and distribution, from a few bands at one apex to dense universal bilateral adhesions binding both lungs firmly to the chest wall. In only a small minority could evidence of healed tuberculous foci be found in the lungs or elsewhere.

Soldiers upon active service, and especially those who are working in the fighting area, are presumably the healthiest possible collection of individuals, and it is surprising that 30 *per cent of them should present evidence of past pleurisy.*

WOUNDS OF THE ABDOMEN ALONE.

During the period dealt with in these notes there are records of 32 autopsies upon penetrating or perforating wounds of the abdomen; for purposes of description and comparison these cases are divided into two main groups, viz.:—

1. Thirteen men who were not subjected to operation.
2. Nineteen who underwent laparotomy.

1. These cases lived long enough to be brought down to the casualty clearing stations, where they arrived for the most part within a few hours of being hit. They all died within twenty-four hours of being wounded, except one who died within thirty-six hours. It may be said of them that their general condition was so bad, and showed so little improvement with rest and warmth in bed and other restorative measures, that it proved impracticable to subject them to an abdominal operation. They died of a combination of shock and hæmorrhage, and it is difficult to apportion the share which each of these factors took in causing death.

As will be seen later, many of those who rallied sufficiently to undergo laparotomy and succumbed later to various complications, presented lesions apparently of the same nature and extent as those for whom it proved impossible to attempt any operative relief; this is also true of the numerous cases in which the operation was successful and the patient recovered.

In the group under consideration there were 9 bullet wounds (4 penetrating and 5 perforating) and 4 shell wounds (all penetrating). The wounds of the abdominal wall were usually quite small: the entry wound about the size of the cross-section of a lead pencil in most cases, and the exit in perforating wounds being generally somewhat—but not much—larger than that of entry. Protrusion of abdominal contents through the wound is exceptional in patients brought back as far as a casualty clearing station; when it occurred, omentum or a coil of gut was usually found, the protruding portion itself often presenting no injury.

The following notes are quoted as exemplifying an average case of this group.

Case 4.—Pte. S. was admitted for bullet wound of the abdomen; he had been hit four hours previously, and on admission was much collapsed, cold, and had a feeble rapid pulse. He was at once put to bed, and the usual restorative measures were applied; these, however, failed to improve his condition enough to make laparotomy possible, and he died within twenty-four hours of being wounded.

At autopsy he presented a small entry wound over the upper part of the left sacro-iliac synchrondrosis and a slightly larger exit wound midway between the umbilicus and right anterior superior iliac spine. On opening the abdomen, the parietal peritoneum showed a slit 1½ cm. long over the left side of the brim of the pelvis corresponding to the entry wound, and a similar slit, ½ cm. long, corresponding to the exit wound.

The peritoneal cavity was 'full of blood'—four pints measured. The greater part of this was fluid, containing some dark-red clot; this appeared to have come chiefly from vessels in the left side of the pelvis and the mesenteric vessels.

The small intestine presented in its lower two-thirds four lacerated perforations, separated from each other by lengths of a foot or more of uninjured gut. Two of these perforations were irregular lacerations involving half the circumference of the tube, and through these the cut edges of the mucous membrane pouted, filling up the tear in the remaining coats; at the other two 'perforations' two or three inches of the whole circumference of the gut had been blown out of continuity. There were two tears about an inch and a half long in the mesentery from which bleeding had taken place, and also two characteristic slits involving only one layer of the peritoneum forming the mesentery. There was no other injury of any viscus.

Of the 13 cases in this group, 8 had lacerations of the small intestine (7 of the ileum and 8 of the jejunum, multiple in each case), 5 of the large intestine—single in each case except one—1 of the stomach, 2 of the liver, 1 of the bladder; 2 had a perforation of the inferior vena cava, 1 of the right external iliac vein. These lesions occurred in various combinations.

Rents and slits in the mesentery, and hæmorrhage into it, were frequently found, and these must have an important effect upon the power of recovery of the corresponding

portion of the intestine. Extensive and well-marked gas gangrene of the abdominal wall and of a large retroperitoneal hæmatoma was found in two of these cases, another instance of the extreme rapidity with which this formidable complication may develop.

Hæmorrhage, both retroperitoneal and intraperitoneal, was a feature common to every one of these wounds. The blood behind the peritoneum frequently presented a large mass of solid clot several inches thick, while that within the peritoneal cavity was fluid, with numerous clots floating in it. In most cases the abdomen was what is usually described as 'full of blood'; measurements, which were difficult to carry out with accuracy, showing that this means as a rule the presence of from 2 to 4 pints of blood.

From this description it will be seen that, broadly speaking, there are three conditions in respect of coagulation in which the effused blood may be found. First, there is the massive clot of the retroperitoneal collection; secondly, the fluid blood with much mushy clot floating in it, which occurs in the peritoneal cavity; and, lastly, the blood in the pleural cavity, which is almost entirely fluid and with only a few visible clots. The difference in these conditions finds a natural explanation in the view that has been put forward by Elliott and Henry[1] to account for what is found in a hæmothorax, for they have argued that the effused blood rapidly undergoes the process of coagulation in all cases of wound, but that where there is much mechanical movement of the blood, as by the respiratory action in the chest, this coagulation is interfered with, and the fibrin is partly 'whipped out', leaving a fluid blood behind.

Wounds of the small intestine were the most frequent lesion in both *Groups* 1 and 2, and they were usually multiple. There was seldom any visible leakage of intestinal contents, even when a portion of the tube had been blown completely out of continuity. Where the intestine was perforated, a lacerated wound, varying in size from a small puncture to a tear involving half the circumference of the bowel, was produced, and the everted edge of the torn mucous membrane pouted into the wound and plugged it. When the gut was completely divided or a portion blown away out of continuity, the severed ends above and below were found to be collapsed and flaccid.

The multiplicity of the wounds is often difficult to understand. Five or six perforations are often found in a few inches of the gut, while in other cases similar wounds may be separated by several feet of uninjured gut. In one case there were no less than ten distinct lacerations in the last few feet of the ileum. These observations suggest that some of these lacerations may be caused by bursting, the intestinal wall having given way as a result of the splash of the blow rather than of having been directly injured by the missile. But no special feature in the lacerations themselves was noticed to lend colour to this suggestion.

Wounds of the large intestine were less frequent, and less often multiple. Leakage of contents was the rule, even with small lacerations; and, with a large tear, fæces have been found freely scattered about the peritoneal cavity.

2. Laparotomy had been performed on 19 cases. These operations were all performed within eight hours of the receipt of the wound, and some of them after an even shorter lapse of time.

Death occurred at various intervals thereafter, namely:—

Within forty-eight hours of wound—6 cases—

5 from hæmorrhage and shock, 1 from gas gangrene.

On the fifth, sixth, and seventh day—6 cases—

4 from ileus, 1 from general peritonitis, and 1 from general peritonitis and bronchopneumonia.

On the eighth, ninth, and eleventh days—3 cases—

From general peritonitis and bronchopneumonia.

On the twelfth day—3 cases—

1 from ileus, 1 from general peritonitis, and 1 from bronchopneumonia.

The remaining case died after a month of general septic infection.

Of the fatal complications, ileus and bronchopneumonia are deserving of remark.

Ileus caused the death of 5 patients who died from the fifth day onwards. It would seem that this condition is attributable in some way to injury to the intestine, its vessels or nerves, and not to septic infection. It was found in various forms, most frequently following resection of the small gut and anastomosis, in which case the distention affected the segment of gut (6 to 12 inches in length) immediately above the line of union, at which point it ceased abruptly. In a case of double resection, this had happened at the upper anastomosis, while the gut on either side of the lower anastomosis showed no signs of paralytic distention. The unions by suture had held soundly in this, as in all the other cases examined.

That the condition is not invariably due to local traumatism to a limited portion of the intestine was shown by a case in which the only wound of the intestine was a single laceration of the splenic flexure which was successfully converted into a colostomy. The patient died on the eighth day, and at autopsy the small intestine was found to be distended. This distention affected the whole ileum, being greatest at the upper end, where the gut was quite six times the calibre of the lower end. The transition was perfectly gradual throughout as the gut was traced downwards to its normal dimensions a few inches above the ileocæcal valve, there being no sudden alteration in calibre anywhere. No injury to the abdominal viscera other than the laceration of the splenic flexure found at operation was discovered, nor was there any peritonitis except the local changes around the colostomy.

Bronchopneumonia was of a definite and uniform type. It was confined to the lower lobes of the lungs, though these do not appear to be simultaneously affected, for the condition was generally found to be more advanced on one side than on the other. In its typical form the whole lobe was almost solid, deeply congested and œdematous, and containing very little air ; portions sank rapidly in water. Areas of solidified lung substance, varying in size from a small marble to a walnut, could be seen and felt, giving the lobe a knobby appearance and feel. On section, these nodules showed a central bead of pus, which exuded from the bronchiole on pressure, and around this was an area of solidification, deep purple or whitish in colour according to the length of time the condition had existed. The tubes throughout the affected lobe showed intense inflammatory changes with abundant secretion. It may be observed that this condition appeared also to be common, clinically, in cases which recovered after laparotomy for abdominal wounds. Probably the initial condition following upon the abdominal lesion was that state of massive collapse which Colonel W. Pasteur was the first to describe.[2] Following upon this collapse, a bronchial infection may have developed into a bronchopneumonia in the fatal cases.

MISCELLANEOUS CASES.

Case 5.—**Meningococcus septicæmia. Death in twenty-four hours.**

Pte. A. E. W. Marched eleven miles with his battalion on April 4, 1916, and did not feel ill enough to report sick till midday on April 5. When first seen a few hours later, he was obviously extremely ill—temperature 101·6° ; pulse 144, small and irregular ; respirations 44; tongue brown and furred. On examining his legs (in which he complained of great pain) the hæmorrhages described below were seen all over the lower limbs and buttocks, and fewer scattered about the arms. These bluish-black blotches, many of them the size of a penny but of irregular shape and varying size, scattered thickly all over the lower limbs, presented a most striking appearance, and at once showed that we were face to face with some very unusual condition. His ankles and feet were exceedingly tender : knee-jerks were brisk and equal, plantar reflexes flexor in type ; Kernig's sign was not obtained, nor was there any stiffness or pain in the neck muscles. He complained of slight headache, but apart from this no symptoms or sign of cerebrospinal irritation could be elicited. The heart was normal in size and position, and the only abnormal physical signs in the lungs were those suggesting early pneumonia, or a thin layer of fluid with some collapse of the left lower lobe. His condition showed no material change during the remaining few hours of his life, and at 2.15 a.m. on April 6 he died, *well within twenty-four hours of the time at which he first felt ill enough to report sick.*

An autopsy on the same day showed : The lower limbs and buttocks present numerous pale blue-black blotches, which are of various sizes and irregular shapes, varying from a pin's head to 3 cm. in diameter. They are present on both surfaces of the lower limbs, being more numerous and larger towards the lower part, and especially upon the feet. A few are scattered

on the arms and forearms, where they are for the most part smaller; there are none upon the hands, trunk, face, or neck. On section they are seen to be hæmorrhages into the deeper layers of the skin, and not raised above the general surface of the skin.

The left pleural cavity contains 10 to 15 oz. of brownish-yellow clear fluid, the right pleural cavity the same quantity of blood-stained fluid; the parietal pleura shows universal injection, the visceral pleura a few tiny scattered hæmorrhages. Both lungs are firm; the cut surface is firm to the touch, and exudes much frothy fluid on squeezing; portions float in water. The spleen is large, soft, and friable. The kidneys are unusually large, pale, and firm; on section the substance bulges and curls up over the cut edge of the capsule, and that of the cortex is covered with glistening slightly-raised points and streaks. The liver presents a similar appearance.

Brain and Cord.—The cortical veins are distended with dark fluid blood; this congestion is specially evident all over the vertex, and gradually diminishes over the lateral aspects of the cerebrum till it disappears at the margin of the cisterna magna. There is no flattening of the cerebrum. No excess of fluid in the ventricles, no hæmorrhages, stickiness, or lymph to be found anywhere. The cord appears perfectly normal, both externally and upon section at various levels. In short, with the exception of the above vascular condition, the brain and cord are quite devoid of any naked-eye abnormal appearances. No other abnormal condition was found in the other organs.

Captain A. W. M. Ellis, C.A.M.S. (No. 5 Mobile Laboratory), examined the blood and cerebrospinal fluid before death at 10 p.m. on April 5, and reported: The blood was inoculated into plain broth, which showed a fairly profuse growth of a Gram-negative diplococcus in eighteen hours. Prolonged search of film preparations from the blood failed to show any microorganisms. A blood-count was not made, but the appearance of the films suggested the existence of a leucocytosis; a differential count of 500 cells showed a considerable relative increase of large mononuclear cells.

Cerebrospinal Fluid.—From lumbar puncture: Fluid absolutely clear, limpid, no clot on standing, no sediment on centrifugalization. Cell-count, 12 per cm., of which 11 were polymuclear leucocytes. The fluid was centrifuged and then poured off, after which the tube was inverted and allowed to drain. The small amount of fluid remaining adherent to the tube was then picked up with a fine capillary pipette, and smeared on a glass slide. This sediment when stained showed a few cells, chiefly polynuclear leucocytes, and large numbers of diplococci, morphologically meningococci. They were practically all extracellular, and were so numerous that 50 to 90 pairs were frequently present in one microscopic field.

Culture and inoculation showed the organisms isolated from the blood and cerebrospinal fluid to be identical, and to be Type I meningococci.

Staphylococcus Aureus Pyæmia.—In civil life it is by no means a rare event to meet with a case in which a local infection by staphylococci, e.g., in a boil, has gradually infected the circulation and led to the development of scattered pyæmic abscesses, particularly in the kidneys, which ultimately prove fatal in the course of an illness of many weeks' duration. The two cases described below illustrate an overwhelmingly rapid development of what is essentially a similar condition. Staphylococcal infections at the front as a rule are benign and local. Occasionally blood septicæmias from staphylococci, mixed with streptococci, have been met with, which caused prolonged fever mimicking enteric, but ultimately cleared up without leaving any local focus of suppuration. The fulminating pyæmia described here is uncommon, but it has occurred also in the experience of other medical officers in France.

Case 6.—Sergt. C. was admitted with a suppurative condition of his upper lip, which had originated in an abrasion a week previously. He was anæsthetized and the lip freely incised, with apparent benefit to the local condition. The following day, however, he developed symptoms and signs of acute pulmonary disease with profound toxæmia. *Staphylococcus aureus* was grown from the lesion in the lip and also from the circulating blood. He died on the third day after admission. At autopsy it was seen that the incised suppurating area lay chiefly to the right of the mid-line of the upper lip, with some swelling of the adjacent skin. Incisions showed in the subcutaneous facial tissue numerous tracks containing dirty-yellow pus; they were distinct from each other, and extended up under the nose and almost to the lower margin of the right orbit, back almost to the right ear, just over the inferior margin of the right horizontal ramus of the mandible, and upon the left side of the face an inch out from the left angle of the mouth. The lower lip appeared normal.

The pleuræ were intensely inflamed throughout, with some recent (as well as old) adhesions; there was about an ounce of yellowish fluid in the right pleural cavity.

The lungs were œdematous and studded throughout with abscesses; many of these were so small as to be only just visible; the largest were as big as a small cherry; and between these extremes they were of all sizes. They were more numerous in the upper lobe. The lower lobes showed a good deal of collapse. There was general bronchitis and bronchiolitis. The remaining

viscera, including the heart and pericardium, showed no macroscopic departure from normal. The brain appeared healthy, except that on the vertex there was evident lymph along the main vessels in the sulci.

The second case, which was admitted within three days of the other, presented very similar features.

Case 7.—Spr. S. was admitted for 'pneumonia'. Although he was evidently suffering from acute pulmonary disease, the case did not appear to be quite straightforward. It was noticed that he had a boil upon the left shoulder; this had been incised, and was, in the patient's opinion, getting better, but during his first three days in hospital it took on a more active appearance, while the surrounding skin became tense and inflamed. Free incisions were made into this area, and *Staphylococcus aureus* was grown from the pus so obtained, and also from the circulating blood. The patient died on the fifth day after admission. The ultimate findings were, in essential, almost identical with those in the foregoing case. Incisions showed pus tracks running from the boil on the shoulder for a radius of 4 in. throughout the surrounding subcutaneous tissues. The condition within the thorax was almost exactly the same: intense bilateral universal pleurisy; lungs studded throughout with abscesses of the same size and distribution; heart and pericardium normal. The only different feature was a circumscribed abscess in the cellular tissue beneath the sternum. The only abnormality found in the brain was evident congestion of the vessels of the vertex.

These two cases were remarkably similar, and it is curious that they should have occurred within a few days of each other. Clinically they differed in that the first case did not show signs and symptoms of acute pulmonary disease until thirty-six hours before death, whereas the second presented them unmistakably for six and probably seven days; at autopsy the lungs of the two cases presented an almost identical appearance, and one could not but believe that the condition had existed for approximately the same length of time in both.

Case 8.—**Thrombosis of internal carotid artery, following contusion by shell fragment. Hemiplegia. Death.**

Pte. L., admitted for shell wound of neck; he presented a wound the size of a sixpence just beneath the right angle of his jaw; on the second day he developed left hemiplegia, and died the following day.

At autopsy it was found that a quadrilateral piece of metal, roughly 1 cm. × 1 cm. × ½ cm., had entered as above, and passed to the opposite side of the neck: it had penetrated the side wall of the pharynx just above and behind the right tonsil, and on the left side was lying upon the fractured upper portion of the ascending ramus of the lower jaw.

On examining the vessels in the right side of the neck, a small piece of metal was found impacted in the outer layers of the wall of the external carotid artery; this had not injured the intima, and the interior of the vessel was normal. Half an inch above the bifurcation of the common carotid artery the lumen of the internal carotid was completely filled with ante-mortem thrombus; this extended in direct continuity through the remainder of this vessel and into the right middle cerebral artery and all its main branches, which were thrombosed for a distance of 3 in. from their origin. Neither anterior nor posterior communicating arteries were thrombosed. There was no fracture of the skull.

The surface veins of the brain—both in sulci and on convolutions—were unusually full of blood. The brain substance corresponding to the area of distribution of the thrombosed arteries was soft and diffluent; this condition was most evident in the region of the island of Reil; upon section it appeared to be limited to an area 3 in. × 2 in in size; but little evidence of softening could be found on examining the external surface of the cerebrum. The only other pathological condition found was a moderate degree of œdema of the lower lobes of both lungs.

There can be little doubt that the thrombosis in this case was due to a blow upon the artery by the metal fragment in its progress through the neck, though no naked-eye evidence of injury to the arterial wall could be found. It would seem probable that in such cases the blow must cause a tear or split in the intima, and that this tear provides the starting-point of the thrombosis.

A series of clinical cases of a similar nature, but without autopsy findings, has recently been published by Surgeon-General Sir George Makins.[3]

Case 9.—**Infection of atheromatous carotid artery. Embolism. Hemiplegia. Death.**

Pte. E. F., age 32, was admitted with a shell wound of the soft parts of his right arm; this was freely opened up and drained, and twenty-four hours later he suddenly developed complete left hemiplegia and hyperpyrexia, in which condition he died fifty-four hours after

admission. Clinically this was attributed to a cerebral hæmorrhage, but at autopsy no naked-eye abnormality could be discovered in the brain. However, in the right internal carotid in the interpeduncular space there was some pink fibrinous clot, which could not be traced beyond the origin of the right middle cerebral artery. The right carotid arteries in the neck were then examined, and at the origin of the right internal carotid was found a nodular mass in the wall of the artery, narrowing its lumen so as almost to obliterate it. Within this narrowed lumen was a small patch of pinkish endarteritis, with a small tag of fibrinous clot attached. Sections showed severe medial degeneration, partly calcareous, and a ring of very severe fatty and calcareous atheroma in the common carotid immediately beneath the bifurcation, very slight intimal hypertrophy of the proximal portion of the internal carotid, and a mixed thrombus containing masses of Gram-negative coliform bacilli on the atheromatous bifurcation and the non-atheromatous common carotid. There were similar bacilli on the surface of the intima and in clefts in the atheromatous intima, extending in one spot as far as the media. Similar bacilli were also present on the surface, and in the outer layer, of the adventitia.

The distribution of the bacilli was doubtless a post-mortem phenomenon to a large extent; but there can be little doubt that infection by bacilli derived from the wound in the arm caused a thrombus to form upon the atheromatous area at the bifurcation of the right common carotid; a portion of this thrombus then broke off and blocked the right middle cerebral artery, causing hemiplegia. The rapidity with which death followed the onset of hemiplegia (thirty hours) probably furnishes an adequate explanation of why no naked-eye changes could be observed in the brain substance, for anæmic softening may be difficult to detect even after an interval of two or three days.

REFERENCES.

[1] Elliott and Henry, *Brit. Jour. Surg.*, 1915, iii, 250.
[2] W. Pasteur, *Ibid.*, 1914, i, 587.
[3] Sir George H. Makins, *Lancet*, 1916, ii, 543.

THE PATHOLOGY OF GUNSHOT WOUNDS OF THE SPINAL CORD:

AS ILLUSTRATED BY THE SPECIMENS IN THE WAR OFFICE COLLECTION.

By Sir WILLIAM THORBURN, Manchester.

The War Office Collection of injuries of the spine and spinal cord now lodged in the Royal College of Surgeons is extensive, and contains specimens of almost every type and result of gunshot wound. In a previous communication[1] the writer has, with George Richardson, illustrated many of the osseous lesions from personal specimens, now lodged in the museum, and Keith and Hall[2] have also described others of the dry preparations. It is now proposed to give some account of the wet specimens, of which there are altogether nearly a hundred. These specimens have been dissected and mounted by Mr. Cecil Beadles, and each is accompanied by a description by Professor Shattock. The drawings which illustrate this paper have been made for me by Mr. S. A. Sewell.

In considering the material at our disposal it will be convenient to classify the wounds met with under certain obvious headings. A missile may lodge in the spinal cord or meninges, may pass directly through these structures, or may merely run in more or less close proximity to the contents of the spinal canal. Again it may, either with or without puncturing the canal, impel fragments of bone or of clothing into the interior, thus producing results closely similar to those of its own impact. In all these cases we find a primary injury of the cord, of its nerve roots, or of the meninges, and as a result of such primary mechanical injury we may meet with secondary infection or other local lesions, and with more distant and remote effects, such as those found in the bladder, kidneys, and lungs.

I. CASES IN WHICH A FOREIGN BODY OR FRAGMENTS OF BONE OR CLOTHING ARE LODGED WITHIN THE SPINAL CANAL.

Case 1 is illustrative of many of the conditions produced by a 'lodging wound' of the cord and meninges. A fragment of high-explosive shell was embedded in the back at the level of the 6th dorsal vertebra, and slightly to the left of the middle line. 'Flaccid paralysis' ensued at once. On the fifth day there was paralysis of both lower limbs: anæsthesia to a line about two inches above the umbilicus on the right side and to a slightly lower level on the left; the bladder was paralyzed; plantar reflexes were of flexor type; no knee-jerks, ankle-clonus, abdominal or cremasteric reflexes. Twenty-four hours later there was found a small 'patch of sensation' on the arch of the right foot and some urethral sensation on catheterization. On the eighth day the patient had definite girdle-pain at the level of the 7th ribs, especially on the left side, and the whole urethra presented some sensation. A skiagram showed two metal fragments, of which one appeared to lie inside the spinal canal. One day later the dorsal wound was excised under local anæsthesia. "The left lamina of the 6th dorsal arch was found fractured and depressed, several pieces of bone evidently pressing on the dura mater; two pieces of shell casing were removed, one somewhat superficial to the fractured lamina, the other actually sticking in the dura mater". On removal of the latter fragment, cerebrospinal fluid flowed into the wound, and there was fully exposed a hole in the theca "about the size of an almond"; "the cord immediately in front of the opening was injured a little, white matter being adherent to the deeper of the metal fragments and to one or two of the bony fragments". The wound was drained.

After operation there was a good deal of collapse and vomiting, but the girdle-pain was diminished; there was some cramping pain in the left lower limb. There followed much headache and increasing retraction of the neck. Lumbar puncture removed turbid blood-stained fluid sterile on culture. Nine days later the patient died with symptoms of severe cystitis, and with a continuation of the headache, retraction of the neck, some divergent strabismus, a tendency to opisthotonos, and marked Cheyne-Stokes respiration.

At the autopsy, on exposure of the spinal theca it was "seen to be bulging particularly towards the head"; the meninges were bound down to the spinal cord at the seat of operation. There was intense hæmorrhagic cystitis.

The specimen (*Fig.* 123, W.O. 391*) shows the changes met with eighteen days after a lodging wound in the mid-dorsal region. The large aperture to the left of the theca is well seen. A minute fragment of metal still remains within the spinal cord. The latter has undergone much local degeneration, but is not completely divided. The theca is deeply blood-stained, and beneath the arachnoid is a purulent and blood-stained exudation more marked below the wound. The bulging of the upper part of the theca observed at post-mortem examination, and the clinical symptoms, alike point to a meningitis much more widely spread than is seen in the local focus. The presence of girdle-pain before operation and the incomplete anæsthesia are alike explained.

FIG. 123.—Fragment of metal impacted in cord; tear in theca, hæmorrhage and septic meningitis.

(This case is much more fully reported than are most of the war specimens. The medical officer was Lieut. Bligh, the operation was performed by Colonel Sir Henry Gray, and the autopsy was by Captain W. S. Lazarus-Barlow, No. 9 General Hospital, France.)

FIG. 124.—Fragment of metal impacted in cord; tear in theca, localized meningitis.

Case 2.—With the above may be compared the very similar injury in specimen W.O. 2206. The wound was at the level of the 9th dorsal vertebra about an inch to the left of the middle line; motor and sensory paralysis were complete below the umbilicus; the bladder was distended, and was catheterized twice on the first day, after which urine was allowed to overflow for several days. On the seventh day a rigor was followed by a rise of temperature to 103°; there were 'evidences of cystitis', and the bladder was irrigated with boracic lotion. Rigors and fever continued, death occurring on the twelfth day.

The specimen (*Fig.* 124) shows a small hole in the theca and a fragment of shell-casing deeply embedded in the

* The letters W.O. followed by a number refer to the War Office number quoted in the College of Surgeons Museum.

spinal cord, which was lightly adherent to the dura. There is here far less local inflammation than in *Case* 1. The dura presents no hæmorrhage, nor is there any marked effusion beneath the arachnoid. The cord presents local crushing with some slight effusion of blood, necrosis around the wound, and turgidity of its vessels. At the post-mortem examination a little early bronchopneumonia of both bases was found. The bladder was much distended, its walls were thick and inflamed, and there was plastic peritonitis in the pelvis, with a small amount of turbid fluid among intestinal coils higher in the abdomen. Both kidneys presented hæmorrhagic pyelitis (*Fig.* 125, W.O. 2206 B), shown in the annexed drawing, to which we shall again refer.

FIG. 125.—Kidney from same case as *Fig.* 124 ; hæmorrhagic pyelitis.

These two cases may be taken, then, as representing a closely similar injury, leading in the one to severe meningitis, and in the other to death from the secondary results of vesical paralysis with no grave local infection.

Case 3 (W.O. 1829) is another illustration of local infection. There was a fracture of the third dorsal lamina on the right side, and a fragment of metal with some adherent khaki cloth had been driven into the spinal cord at this level. The cord is here quite soft and diffluent. There is a good deal of surrounding meningitis, and some two inches below the crush of the cord is a small patch of meningeal hæmorrhage about a millimetre in thickness, with surrounding œdema. The drawing (*Fig.* 126) shows the small piece of cloth below the metal fragment, and also a slight depression at the site of the more remote hæmorrhage. There was some extradural hæmorrhage. The direct cause of death was acute pulmonary œdema with bronchopneumonia and an infarct in the left lung.

FIG. 126.—Metal and cloth impacted in spinal cord ; meningeal hæmorrhage and meningitis.

Case 4 (*Fig* 127, W.O. 2026) is a further illustration of the extent of the intramedullary destruction met with in nearly all direct wounds of the cord. A shell wound was received in the left loin opposite the 1st lumbar spine, and paraplegia was complete ; 'laminectomy' was at once performed, and the large fragment shown in the drawing was removed from the spinal canal ; but death followed the day after injury and within a few hours of operation. A large piece of cloth, not removed at operation, was found embedded in the cauda equina. There is complete destruction of all the nerve-roots and conus medullaris, with hæmorrhage and early acute meningitis, causing subarachnoid exudation as high as the upper part of the specimen. At the upper limit is shown a transverse section of the cord which presents a small hæmorrhage into the anterior cornu, and a second one beneath the arachnoid. In this case there was no time for the development of secondary urinary troubles, and death must have been the direct result of initial shock and septic infection. Few of the cases have been so quickly fatal, and the extent of the hæmorrhage into the cord and rapid spread of meningitis are well shown.

Case 5 (*Fig.* 128, W.O. 263) is an illustration of a wound in which the metal fragment

has passed tangentially to the spinal canal, but in which a fragment of bone has been detached and has given rise to a 'lodging wound'. A piece of shell passed from left to right across the back at the level of the 3rd and 4th dorsal vertebræ, penetrating the chest, wounding the apex of the right lung, and lodging in the right side of the neck. The right chest is described as having been found full of blood, but the duration of life is not stated, and there is no clinical history. In its course, the piece of shell has grazed the right laminæ of the 3rd and 4th dorsal vertebræ, detaching two small fragments of bone. These are seen to have been driven in, cutting the dura mater and partially dividing the right side of the spinal cord. There is here no direct septic infection of the theca or its contents, and the local conditions are therefore more like those of a simple fracture than of a gunshot wound with direct entry of the missile. Hence there is an absence of severe meningitis, and in many such cases there is also neurological evidence that the cord is only partially injured, so that the symptoms are often of the Brown-Séquard type.

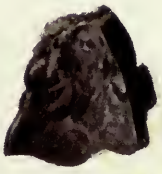


FIG. 127.—Impaction of large fragment of metal and large piece of cloth in cauda equina; hæmorrhage and meningitis.

Case 6.—A similar example is furnished by a case which came under my own observation in France. There was a small clean wound on the right side of the neck, with paraplegia. On admission, the arms were folded on the chest with the forearms supinated. All four limbs and the intercostal muscles were paralyzed; there was no knee-jerk, and no sole reflex; urine was retained. Epicritic and protopathic sensation were lost, except that some vague deep sensation was retained in the right thigh. On the fourth day, when I saw the patient, he could feebly move all muscles of the left upper limb except those of the hand; in the right upper limb contractions could be defined in the deltoid and flexors of the elbow; there was slight power of moving the hips and flexing the ankles; the intercostal muscles were acting feebly but distinctly. Knee- and ankle-jerks were present and exaggerated; the sole reflex was extensor. The bladder could be emptied voluntarily. Anæsthesia of the trunk extended to the level of the cervical nerves; the right upper limb was anæsthetic, except on its outer side (5th segment); the left upper limb was anæsthetic only as high as the distribution of the 8th cervical or 1st dorsal segment. (The Brown-Séquard type of paralysis was thus indicated clearly in the upper limbs.) Some improvement continued for over three weeks, at the end of which time the medical officer operated, exposing the 4th, 5th, and 6th cervical laminæ. A small punctured fracture was found on the left side of the 5th cervical lamina, which was removed, exposing an opening in the theca adherent to the spinal cord. The adhesions were separated, when there was a free flow of cerebrospinal fluid. Respirations became very slow and feeble, and death occurred as the skin wound was being closed.

FIG. 128.—Impaction of fragments of bone in spinal cord; no septic infection.

The specimen (*Fig.* 129, W.O. 2472) shows a small metal fragment and a spicule of

bone derived from the 5th cervical lamina but lying just under the 4th. Both fragments have penetrated the theca, and have been carried slightly upwards to the left of the spinal cord, which is partially divided at about the level of the 6th segment. The fragment of bone is resting in the cord, the metal applied to the theca between it and the cord. There is no meningitis, and the area is apparently quite free from sepsis.

FIG. 129.—Impaction of metal in theca and of bony fragment in cord; no septic infection.

This case is of very great interest from several points of view. It illustrates the absence of marked secondary infective changes in many of the wounds due to clean fragments of metal or detached pieces of bone. The clinical symptoms were characteristic of this type of lesion. The case was one of the comparatively few examples in which laminectomy could have been of real value, and a successful result was to be anticipated. Without considering minutely the indications for such an operation, it is clear that a lodging wound presents a mechanical objective which does not otherwise obtain. Equally, if after recovery from the early stages of spinal shock there be limited symptoms with a tendency to recovery, the cord cannot be entirely destroyed, and it should be relieved of any foreign body or clot which is in contact with it. And again, the absence of vesical symptoms and of any obvious wound sepsis render such a case eminently favourable. Those present at the operation were unable to give me a clear account of why, in this unfortunate instance, it was directly fatal.

II. CASES IN WHICH THE MISSILE OR OTHER FOREIGN BODY HAS TRANSFIXED THE CONTENTS OF THE SPINAL CANAL.

FIG. 130.—Entry wound through laminæ (*Case* 7).

FIG. 131.—Penetration of laminæ (*Case* 7).

In the preceding group we have cases in which some foreign substance has entered and remained within the spinal cord or its nerve-roots (lodging wounds), and we may now

turn to a group in which the mechanical cause of injury has passed on, leaving a similar wound with similar ultimate results, although the foreign body is no longer present.

Case 7.—In this case we have a whole series of specimens showing in detail a course of events which is quite common under such conditions (W.O. 594 A and 594 B). The patient was admitted to No. 9 General Hospital with a 'dirty-looking wound', about an inch in diameter, to the right of the spine at the level of the iliac crests. (A second through-and-through wound of the gluteal region is of no practical importance.) No vertebral injury was detected, and there is said to have been no paralysis and no alteration in reflexes. The man looked very ill, and, on admission, complained of pain in the neck; temperature 102°; the wound appeared to run towards the lumbosacral joint. On the following day abdominal pain was found to be due to a distended bladder, and, although small quantities of urine had previously been passed, he had retention to the end of life. On the third day he was very ill, with muttering delirium and a temperature of 104°. Lumbar puncture yielded a very small quantity of fluid under low tension; it was slightly turbid and gave a pure culture of streptococci. On the fourth day he died.

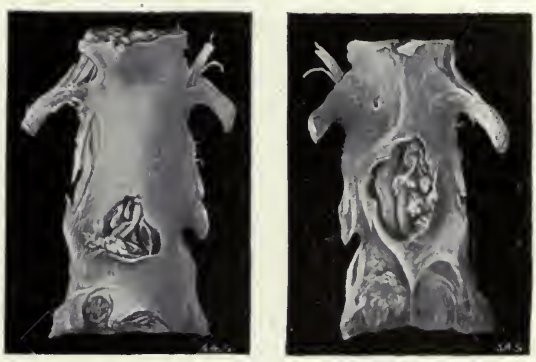


FIG. 132.—Penetration of theca and cord (*Case* 7).

FIG. 133.—Septic meningitis extending up entire cord (*Case* 7).

The autopsy was made by Captain Lazarus-Barlow. From behind there is seen (*Fig.* 130) a wound through the ligamenta subflava, between the 4th and 5th lumbar laminæ, and in this region a little pus lay outside the spine. Looked at from the front (*Fig.* 131) the specimen shows a small sharply-cut fracture of the 5th lumbar arch. The subjacent theca is cleanly perforated, and the cauda equina partly, but by

no means completely, torn (*Fig.* 132); the nerves and meninges in this region were blackened. Finally, the foreign body was discovered only on section of the vertebral bodies, which exposed a fragment of metal lying deeply in the 4th–5th intervertebral disc (*Fig.* 134). Meningitis extended upwards as far as the 1st dorsal vertebra, and the entire cord is here reproduced to show the extent of the exudation (*Fig.* 133). In addition to the intense congestion of the lower part of the meninges and of the medullary vessels, subarachnoid exudation is shown running up the cord, and we have a complete picture of a streptococcal spinal meningitis of four days' duration.

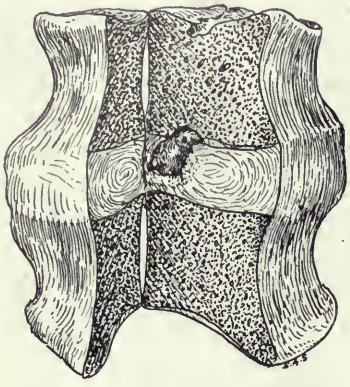


FIG. 134.—Lodgement of metal fragments (*Case* 7).

Case 8 (W.O. 350) shows a similar injury, with greater mechanical damage but far less serious septic infection. The theca is perforated transversely at the level of the 1st lumbar vertebra, and the cauda equina is almost torn across, a small fragment of bone still present (*Fig.* 135) showing the injury to have been due in part to the missile and in part to bony débris. There is little meningitis, though the post-mortem examination of other regions shows that life must have been preserved for some time. A bullet had entered the 9th intercostal space in the left mid-axillary line, passing through the pleura, the posterior margin of the spleen, and the middle of the left kidney, to the right lumbar region, whence it was extracted by operation. There was blood in the pleura and in the peritoneum, with slight fibrinous peritonitis, much perirenal hæmorrhage with purulent fluid in the retroperitoneal tissues, a fibrinous clot closing the wound in the spleen, pus around the resting-place of the bullet, cloudy swelling of the liver and right (uninjured) kidney, acute cystitis with hæmorrhagic foci, and œdema of the descending colon. Hence the specimen illustrates the severe mechanical injury and comparatively slight sepsis of a clean bullet wound of the vertebral canal.

FIG. 135.—Transverse section of cauda equina; little meningitis.

FIG. 136.—Section of spinal cord; slight secondary changes.

Case 9 (*Fig.* 136) shows equally a severe mechanical injury with slight meningitis. The bullet had perforated the arch of the 7th dorsal vertebra, transfixing the theca, almost dividing the cord, and then tearing a large ragged hole in the right lung. The drawing (*Fig.* 136) illustrates the condition of the medullary vessels in an early case of this type. (No clinical notes are obtainable.)

Case 10 (W.O. 411) illustrates a perforation in which life was prolonged for nearly a month. On Nov. 4, 1915, the patient was wounded by a piece of shrapnel on the right side of the neck, three inches below and a little posterior to the tip of the mastoid process. There was complete paraplegia below the nipple, but the arms are said to have presented no paralysis or anæsthesia. On Nov. 8, laminectomy was performed, and a fragment of shrapnel-casing measuring $\frac{3}{8}$ in.

by $\frac{1}{8}$ in. was found to the left side of the cord. The dura was torn, as were the posterior fibres of the spinal cord (*Fig.* 137). The wound healed aseptically, but paralysis was not improved, and death occurred on the twenty-eighth day. The very clean perforation is here represented by a glass rod, and it is clear that there has been no spreading meningitis.

FIG. 137.—Perforation of spinal cord; no septic changes. Result after one month.

III. CASES OF CONTUSION OF THE CORD BY DIRECT IMPACT OR BY TANGENTIAL WOUND.

In the two last groups of cases we have been concerned with injuries in which the missile or a fragment of bone has penetrated the dura mater and wholly or partially divided the spinal cord or its roots; we may now pass to those in which there has been no mechanical section, but in which the injury is due to a mere bruise. Such a bruise can be inflicted in one of several ways, which are illustrated by the following examples.

Case 11.—(*Fig.* 138, W.O. 2724). In this case, of which there are no clinical notes, a shrapnel bullet has impinged upon the 1st lumbar arch, and, entering the spinal canal, has come to rest on the right side, where it lies between the intact theca and the fractured lamina. It will be sufficiently obvious from the drawing how in such a case the cord is contused, and if the blow be sufficiently severe is converted into a mass of débris and blood-clot. This type of injury was rather common in the lumbar region, where the spinal canal is large, and was not infrequently due to shrapnel bullets of low velocity. Paraplegia naturally ensued, and the specimen is accompanied by the bladder and kidney, which well illustrate the usual method of death in such cases. The bladder, shown from its inner aspect (*Fig.* 139), presents intense congestion, with thrombosis of its veins and scattered patches of ulceration. The kidney presents numerous cortical infarcts, and should be compared with the kidney of *Case* 2, in which we have a quite different type of secondary lesion; in the latter the inflammation has taken the form of a hæmorrhagic pyelitis; in this instance (*Fig.* 140) the pelvis had undergone little damage, but the cortical metastatic lesions are well defined.

FIG. 138.—Lodging shrapnel bullet with contusion of cord.

Case 12 (W.O. 881) is an illustration of a slightly less obvious contusion, and presents several points of interest. *Fig.* 141 shows from behind a rifle bullet embedded between

FIG. 139.—Bladder from case shown in *Fig.* 138, inverted; cystitis, ulceration, thrombosis.

FIG. 140.—Kidney from case shown in *Figs.* 138, 139; cortical infarcts.

FIG. 141.—Bullet with base projecting into spine; fragments of casing shown in its track.

FIG. 142.—Projection of base of bullet into spinal canal tear of dura mater, contusion of cord.

the 5th and 6th dorsal spines. To the left of the bullet are seen bright specks of copper from its casing, and such are often of practical value, as they stand out as minute shadows in a skiagram and may usefully indicate the course taken by the bullet. In the present instance it is obvious that this has entered and has come to rest with its base in front. Turning now to the opposite side of the specimen (*Fig.* 142), we find that the base of the bullet has just failed to enter the spinal canal, but has here produced a salient, impinging upon the posterior aspect of the theca, in which are two small tears with a little hæmorrhage. The cord was here reduced to blood-stained débris.

FIG. 143.—Tangential wound of meninges; contusion of cord (*Case* 13).

Case 13 (W.O. 384) shows a third form of contusion, in which the injury is tangential to the cord. A bullet entered one inch below the angle of the jaw on the left side and passed out to the right of the cervical spine. Its track is shown (*Fig.* 143) skating the arachnoid, which is here torn, and there is a thin layer of subarachnoid hæmorrhage extending for a considerable distance on either side of the glancing blow. The patient died on the third day, with complete paralysis and anæsthesia below the 8th cervical segment. In such cases the injury inflicted upon the cord is apt to extend far beyond the region of direct contusion, and the accompanying drawings (*Figs.* 144 and 145) of specimen 384 A are introduced to show how widely spread is the necrosis produced by the same bullet in the tissues of the back and at the point of exit. Even allowing for the fact that at this stage it would be accompanied by fragments of bone from the cervical laminæ, its 'divulsive' action has inflicted an amount of damage upon muscle, fat, and skin which fully prepares us for the widespread injury of the less resistant spinal cord.

FIG. 144.—Track of bullet (*Case* 13); extensive hæmorrhage and necrosis.

FIG. 145.—Exit of bullet (*Case* 13).

Case 14 (W.O. 1433) is a further illustration of the result of a tangential injury, and is accompanied by a specimen of the aorta from the same case to allow comparison of a similar injury to these two very different structures. The bullet entered to the right of the 1st dorsal vertebra, passing through the spine, driving bony splinters into the hilum of the left lung, and then becoming embedded in the upper lobe of the latter, with its point projecting on the pleural surface. The patient, who was paraplegic, died in sixty hours with the symptoms of severe hæmorrhage. The left pleura was full of blood, and left lung collapsed. The aorta "seemed to have been untouched", but "lay immediately adjacent to the track of the bullet" (*Fig.* 147). On its inner aspect, at the point which the bullet had crossed, are a few minute cracks in the intima, and a small clot projecting like a polypus. As regards the spine, the bullet is found to have passed through a spinous process, grazing the left side of the dura mater, which presented a tear 1½ in. long (*Fig.* 146); the spinal cord showed no external change, but paraplegia was complete. (Another specimen shows the remainder of the spine with exit of the bullet through the left side of the body of the vertebra.)

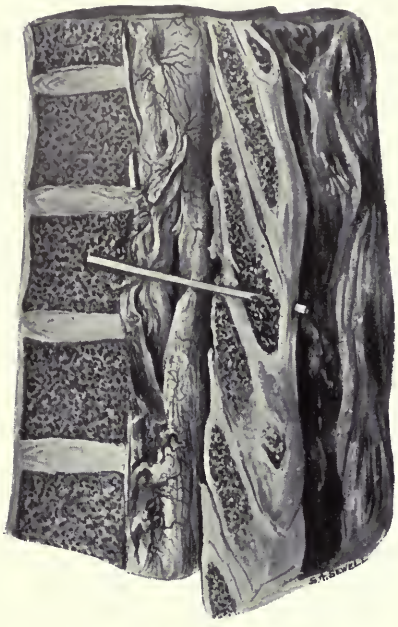


FIG. 146.—Tangential wound of spinal cord.

FIG. 147.—Tangential injury of aorta from same case as *Fig.* 146.

FIG. 148.—Contusion of membranes and cord without penetration of vertebral canal.

Case 15 (W.O. 313) is an example of a form of injury which is probably quite uncommon. A bullet entered the left side of the neck just behind the centre of the sterno-mastoid muscle, and passed out immediately above the upper angle of the right scapula. Paralysis was complete, and death followed within thirty-six hours from respiratory failure. The bullet was found to have traversed the base of the 7th cervical spinous process, without penetration of the vertebral canal; but, on laying open the bones, there is here found a partial dislocation of the spinal column; between the last cervical and first dorsal vertebræ is seen a horizontal tear in the ligamenta subflava, and three or four of the vertebral bodies have been slightly wrenched apart into a position of hyper-extension. The whole of this region of the

spine thus presents an exaggeration of its normal anterior convexity; there is hyperextension of the cervicodorsal junction as from a severe but widely diffused impact upon the back of the neck; the divulsive action of the passing of a missile at high velocity is thus carried to an extreme degree, and the contents of the spinal canal have suffered from subluxation in extension instead of from the subluxation in flexion which is so characteristic of the injuries of civil life. (This bony specimen is in the museum, but the condition cannot be shown on a plane surface.) There was much diffused hæmorrhage into and around the bones, and the vertebral canal was palpably full of blood.

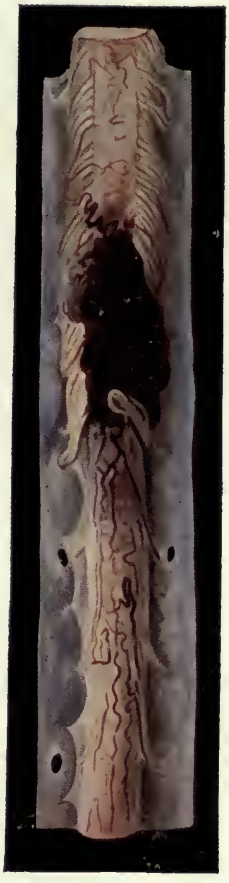


FIG. 149. — Contusion of cord; no injury to theca.

The specimen (*Fig.* 148) illustrates admirably the usual appearances of extensive hæmorrhage into the membranes and cord. It is important to note that in this and other similar cases the amount of hæmorrhage, although sufficiently great having regard to the region in which it is situated, is rarely if ever sufficient to fill up the theca or to yield any large amount of blood from lumbar puncture. Cerebrospinal fluid obtained by the latter means may present slight reddening or may show blood-cells microscopically, but we have not found such quantities of blood as to produce any direct pressure in distant parts of the theca.

FIG. 150.—Extensive softening of cord from contusion; no injury to theca.

The above cases illustrate the *mechanism* of contusion of the spinal cord; those which follow show some of the *results* of such injury.

Case 16 (W.O. 469) is an example of severe hæmorrhage from contusion in the cervical region. The bullet entered the right side of the neck behind the sternomastoid muscle, splintering the right lamina of the 7th cervical vertebra and coming to rest in the muscles of the back near the 1st dorsal spinous process; from its short course and ready arrest its velocity was probably low. The theca is quite uninjured, but there is extensive hæmorrhage in the arachnoid and cord, extending well above and below the region struck (*Fig.* 149). It is noteworthy, however, that in this instance, in which the velocity was probably not high, the hæmorrhage is far more localized and well defined than in most of our cases.

Case 17 (W.O. 2027) is that of a man who died six days after a wound in the neck. There was a fracture of the 6th and 7th cervical spinous processes and laminæ, with complete paraplegia, hyperpyrexia, and pneumonia. The post-mortem examination showed a large amount of extradural blood-clot extending over the lower cervical region and reaching to the upper dorsal vertebræ; but the theca was untorn, no foreign body was found in the spinal canal, and there was no meningitis or intrathecal hæmorrhage. The specimen (*Fig.* 150) shows an extensive area of softening in the lower cervical region. In this case it is

possible that there may have been a direct bruise of the contents of the vertebral canal by bony fragments which have subsequently recoiled; or alternatively, the bruise may have been due to the divulsive effect of the bullet upon surrounding soft parts, as shown in *Case* 13. The lesion of the cord is not of a type which could be produced by the mere pressure of extrathecal hæmorrhage.

FIG. 151.—Slight bruising of theca; extensive injury to cord.

A similar condition is better shown in the coloured drawing of *Case* 18 (W.O. 2072). Here death occurred on the sixth day after a wound in the middle line over the 2nd dorsal spinous process causing complete paraplegia. At the post-mortem was found a fracture of the 2nd dorsal spinous process, and a piece of metal one and a half inches in length, with some fragments of cloth, was embedded in the left lamina of the 4th dorsal vertebra, at which point it had projected slightly into the spinal canal without dividing the theca. There was an extradural hæmorrhage, with some pus, over an area four inches in length. (Other post-mortem findings were cystitis, pyelitis, œdema of the lungs, and some gas infection of liver, spleen, and kidneys.) The specimen (*Fig.* 151) shows a slight indentation of the dura opposite the 4th dorsal lamina, with remains of the extradural coagula, and contusion of the cord with numerous hæmorrhages into its substance extending over an area of about four inches. It is here obvious that any direct bruise can only have occurred in the lower part of the damaged area, while the more severely injured part above could only be affected by transmission of the mechanical impulse through soft tissues or unbroken laminæ.

FIG. 152.—Extensive hæmorrhage from slight bruising (or concussion) of cord.

Lastly, in *Case* 19 (W.O. 451) we have a case in which a shell wound in the cervico-dorsal region caused a fracture of some of the spinous processes, but did not open the vertebral canal. A series of sections taken over a distance of three inches (*Fig.* 152) shows admirably the extent of hæmorrhage into the cord in such a case of contusion, or as it is sometimes called, 'concussion'. The bleeding, which is more severe on the left side, shows a marked tendency to affect the grey matter rather than the firmer white fibres, and takes the general form of a much tapering spindle, an arrangement which is also commonly seen in the hæmorrhage which extends above and below the crushing injuries of fracture-dislocations in civil life. The same arrangement can be demonstrated clinically to have occurred in many cases which recover, leaving an atrophic paralysis of certain segmental areas, with little evidence of injury to ascending and descending fibres.

MENINGITIS.

Reference has been made in several of the above cases (notably *Case* 6) to the adhesions by which apertures in the theca may be sealed as are aseptic wounds of the cerebral membranes. Such local repair can, however, occur only in the absence of septic infection, the adhesions produced are generally very feeble, and the theca presents great powers of complete repair. It is quite usual for the separation of such adhesions to be

followed by a gush of cerebrospinal fluid, and in many cases this release has been described at operation as due to the opening of a subarachnoid cyst. In some, no doubt, there is a localized collection of fluid, but in others there is merely a release under normal tension

FIG. 153.—Extension of septic meningitis upwards along cord.

FIG. 154.—Lower part of cord from same case as *Fig.* 153, showing extent of meningitis.

of the fluid above and below, and it is not unusual for such fluid to be projected for a vertical distance of several inches through a small incision in the arachnoid.

In gunshot wounds there is, however, a grave risk of septic infection, and many of the above cases illustrate the appearances produced by such local infection. The dura

is reddened and congested, while exudation within the arachnoid covers the surface of the cord with a creamy layer of pus. Definite abscesses are rarely if ever found, and I have not met with any evidence of local accumulation of gas, probably because death precedes the development of such conditions.

The meningitis presents a strong tendency to spread, which is well shown in *Case* 20 (W.O. 1832) (*Figs.* 153, 154). This man was admitted to hospital with a through-and-through bullet wound passing from right to left across the back at the level of the 12th dorsal vertebra. He presented complete flaccid paralysis of both lower limbs, with paralysis of bladder and rectum. All power of sensation was lost from (? including) the 1st lumbar segment, except a small triangle under Poupart's ligament on the left side. There was a fracture of the spine, of which the exact nature is not described. Laminectomy was performed the day after the wound, and the cord was exposed through the 12th dorsal and 1st lumbar laminæ. On the ninth day there is a note reading, "Meningitis—general condition worse—paralysis never improved", and on the twenty-third day he died. Supplementary clinical notes, which unfortunately bear no date, refer to diminution of sensation of touch and pain below the 5th dorsal segment, hyperæsthesia to rubbing in both flanks, weakness of the lower part of the rectus abdominis, and exaggeration of abdominal reflexes on the right side with diminution on the left.

FIG. 155.—Septic meningitis with much exudation.

The post-mortem examination by Captain T. H. O. Shore showed extradural hæmorrhage extending from the wound up to the mid-dorsal region, intradural hæmorrhage and purulent meningitis to the upper dorsal region, and softening of the cord about the wound. In the brain there was extensive purulent meningitis, with pus in the ventricles and a small hæmorrhage in the floor of the 4th ventricle. It is noticeable —especially in connection with the next case—that extensive as is the spinal meningitis, it tends to fade away in the upper part of the thecal canal, while it is again more active in the cerebral meninges. Also it is here remarkable that the extension has occurred solely in an upward direction, the subarachnoid space below the lesion having apparently been sealed off by adhesions (*Fig.* 154). Such a distribution is quite usual, and for this reason a thecal puncture below the level of the lesion may fail to indicate the severity of the meningitis above.

In the great majority of such cases of meningitis—which are probably due to a streptococcal infection as in *Case* 7—the inflammation is, as would be expected, directly continuous; but the following is a remarkable illustration of what might at first sight appear to be a separate focus of infection.

Case 21 (W.O. 468) is that of a man who had received two wounds thus described in the post-mortem report by Captain Hubert Henry, 13 General Hospital, Boulogne: (1) "A large gaping septic wound over lower lumbar region in middle line, with tearing of the base of the dural sac"; (2) "A second smaller wound over 10th and 11th ribs, two or three inches to right of mid-dorsal line", slight and superficial. There was no head injury. The note adds: "Said to be a case of pure infection with *B. perfringens*". No clinical history is obtainable.

The lumbar region of the spinal cord (*Fig.* 155) shows a typical area of septic meningitis, with the usual accumulation of pus beneath the arachnoid, and with prominent congested vessels in the cord; the dura mater presents little if any change. On the vertex of the brain there is another area of similar inflammation (*Fig.* 156). There is

here a thick deposit of densely-packed yellow pus with well-defined margins, almost limited to the vertex but extending slightly towards the Sylvian fissures. The post-mortem report states that "there is little evidence of meningitis at the base"; the specimen shows none, nor does the upper part of the spinal cord. This is the only case in which we have found so isolated a patch of remote meningitis, but there is no

FIG. 156.—Brain from same case as *Fig.* 155, showing vertical meningitis.

reason to regard the condition as a pure metastasis; it probably resulted from a direct extension of infection which has failed to evoke active reaction at lower levels, and has thus, by allowing life to be prolonged, had the opportunity to develop to an unusually high degree at its upper limit, a tendency to remote exacerbation also seen in *Case* 20.

SUMMARY.

In concluding this survey of a selection of specimens from the very fine collection in the War Museum, we may perhaps lay down the following general propositions :—

Gunshot injury of the spinal cord may be due to :—

1. The direct impact of a missile, which may either penetrate it completely, or remain embedded in it, and which is liable to be accompanied by fragments of clothing, and especially of bone.

2. The indirect impact of fragments of bone, which again may penetrate completely, may remain embedded, or may recoil towards the positions from which they were dislodged, although such recoil is far less common and less obvious than in fractures of the vertebral bodies as seen in civil life.

3. Contusion by : (*a*) Foreign bodies which enter the spinal canal but do not penetrate the theca ; (*b*) Displaced fragments of bone protruding slightly into the vertebral canal ; (*c*) Displacement of the soft parts only, or, rarely, subluxation of the bones (*Case* 15)—the widely-spread divulsive or 'explosive' action of a missile passing by at a high velocity.

In all cases the cord is liable to present mechanical destruction and hæmorrhage extending widely beyond the area of apparent injury, and affecting especially the grey matter of the anterior cornua, where it produces long spindle-shaped areas of destruction. Such extension of hæmorrhage is more widely spread where the missile is of higher velocity.

In the case of direct impact by foreign bodies, septic meningitis will generally ensue, but such meningitis is less common when impact is due only to fragments of displaced bone. It is generally absent in contusions of all forms, and the untorn dura mater is highly resistant to infection.

Meningitis tends strongly to extend upwards rather than downwards, and is usually continuous, but may spread unobtrusively along the membranes, to blaze up at remote points.

Hæmorrhage sufficient to cause serious compression is very rare, but it is usually present in such quantities that, should life be prolonged, it may readily give rise to well-defined cicatrices, which will tend to assume the annular and constricting type often found at operation.

REFERENCES.

[1] Thorburn and Richardson, *Brit. Jour, Surg,*. 1918, vi, 481.
[2] Keith and Hall, *Ibid.*, 1919, vii, 67.

VISITS TO SURGICAL CLINICS AT HOME AND ABROAD.

SIR ARBUTHNOT LANE AT GUY'S HOSPITAL.

The second number of this Journal contains an account of Lane's technique in open operations for fractures of the long bones, and in a later issue Lane described the details of his operation of colectomy. While on the one hand these articles somewhat limit the scope of the present paper, yet they allow of the omission of a quantity of technical detail, and permit of attention to general principles which, as in this instance, can be picked up by repeated visits to the clinic of an original-minded surgeon.

The present writer has so long observed Lane's work that he can recall the phase of his interest in mastoid surgery, which attracted attention in 1889 by the publication of five cases of lateral sinus thrombosis treated by operation: priority in this field must be accorded to Horsley, in this country, who recommended ligature of the jugular in 1886 and carried it out in 1888, but it is believed that Lane's was the first British paper in which actual cases were recorded.

To Lane must be given credit for resection of ribs for the drainage of acute empyemata in children which, up to the time of his paper in the Guy's Hospital Reports of 1883, had, when treated surgically, been drained by an incision through an intercostal space.

On a recent visit Sir Arbuthnot Lane dealt by open operation with a T-shaped fracture of the lower end of the humerus in a youth.

It has been the custom of many critics of Lane's work to assume that he makes a practice of operating on every fracture: this is not a fact. Lane holds very strongly that good anatomical reposition is an essential in the treatment of fractures, and it may be that his definition of 'good' in this relation has a higher value than would be required by some other surgeons; but as one who has had the opportunity of following his practice in the treatment of fractures, the writer can confidently assert that operation is undertaken only when the ordinary non-operative measures fail to restore the normal position or to maintain it. In the case under consideration an attempt had been made under an anæsthetic to reduce the deformity; but this failed, and x rays in two planes confirmed the opinion that no improvement had resulted.

The transverse limb of the T was supracondylar, and the vertical limb ran downwards and inwards through the trochlea; of the two lower fragments the inner was very small and mainly intra-articular. With a thin four-hole plate the outer lower fragment was brought into normal relationship with the shaft. The skin wound was closed with Michel's clips, without any ligatures or suture of the deep tissues. Lane attaches importance to the placing of these clips very near together throughout the whole length of the skin wound; by this the escape of blood is prevented and any risk of infection from the surface is avoided.

In the after-treatment of such cases massage is employed as soon as the wound is healed and the clips are removed; no passive movements are allowed, but active movements are encouraged from the date at which normal union occurs in simple fractures, i.e., after about four weeks in the case of the humerus. This patient was able to carry out active, painless, free movements through ninety degrees after some eight weeks under such treatment.

Lane does not think that operative treatment of simple fractures exercises any delaying influence on union; he holds that in compound fractures—and this is particularly true of old gunshot fractures—such delay in union is due to septic infection of the bone itself. This is particularly important in the case of the femur, and necessitates the wearing of a caliper, or some similar apparatus such as a Hœfftcke's splint, for some months.

Only simple fractures are subjected to early operation; if in a compound fracture the displacement cannot be controlled by splints, the wounds are allowed to heal and no operation is undertaken until some weeks have elapsed after firm union of the wound; this is an interesting reflection upon the early attitude of the profession to Lane's intro-

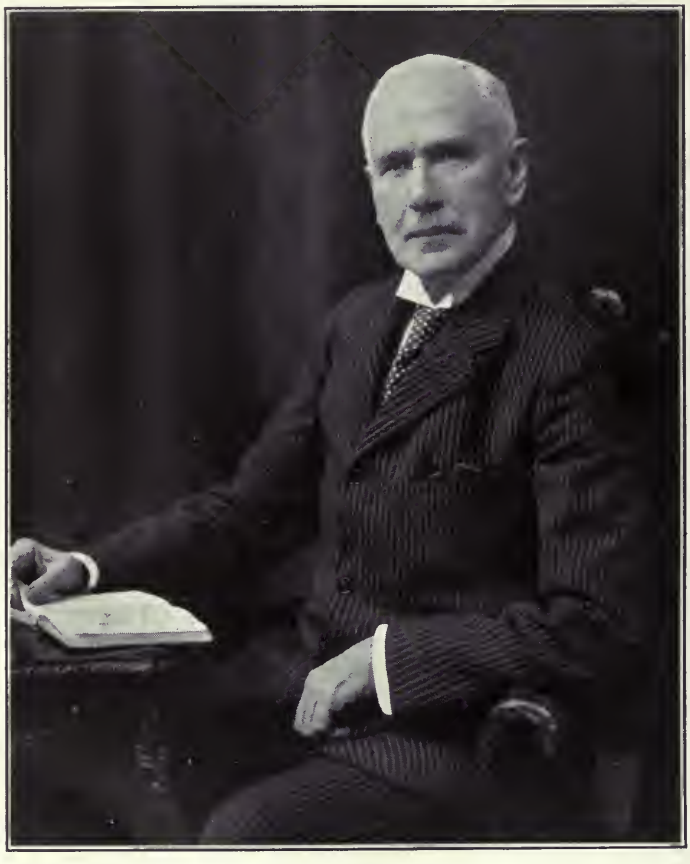


FIG. 157.—Sir Arbuthnot Lane.

duction of the operative treatment of fractures, for there was a wider tendency to concede its application to compound than to simple fractures, as it was admitted that a wound already existed in the former, and the supposed risk or danger of converting a closed into a compound fracture did not exist.

When dealing with fractures of the lower extremity, particularly in late cases, much overlapping of the fractured bone is brought about by muscular shortening; this is exceptionally marked in the femur. In order to overcome this, Lane frees the two ends subperiosteally for some distance, and then, in the case of the femur, has the limb below the fracture strongly adducted; the two ends are then brought into apposition, and the limb is straightened, when the shortened muscles are stretched by the leverage of the bone

without much effort of pulling by his assistants. It is remarkable, on observation of this simple method, how easily shortening is overcome, so that much less bone has to be removed in order to get good alinement than might have been imagined.

Lane has repeatedly demonstrated from *x*-ray plates of fractures plated some months or years previously, that plates and screws do not cause bone absorption or rarefaction, provided the parts remain sterile. In all such aseptic bones there is no area of abnormal translucency around the screws, and if for any mechanical reason such as the vicinity of the plate to a joint or the growing end of a bone its removal is desirable, the screws will have to be removed with a screwdriver, as the screw-thread in the bone is maintained indefinitely.

Lane has perfected his 'no touch' technique by long practice, and a visit to him is well repaid in observing how, through a long and tedious afternoon occupied by two or three bone-platings, he has trained his assistants to carry out this practice so that failures are very rare indeed.

At the time of my visits Lane was interested in the causation of abdominal adhesions after laparotomy, and particularly after intestinal resections such as colectomy. He held that preservation of the omentum was an important detail, and in recent years modified his technique with this object in view, though he often remarked that in cases of stasis the omentum was usually defective both in length and size. He had been experimenting with the use of various fluids for the protection of the intestines so as to obviate the formation of adhesions, and for a long period all swabs and towels which came into contact with the bowel-wall were saturated in liquid paraffin; but after prolonged trial it was found that their use exercised no protective influence against the formation of adhesions.

To those who, like the writer, have had the privilege of watching the gradual evolution of Lane's colectomy technique, his very small operative mortality is no matter for surprise; having seen this on scores of occasions, I have never left the theatre without regret, and a feeling that one had seen something done as well as it could possibly be done. It surely is the master alone who through long years can inspire his juniors with increasing admiration, both for the ingenuity of his view-point and the dexterity of his manipulations. Lane's colectomy technique has not noticeably altered since he described it in the eighth number of this JOURNAL, where the reader in search of detail will find all that he needs. It seems that Lane's perfection as an abdominal technician rests on the following points:—

1. His free incision, permitting adequate exposure of organs, their inspection and palpation providing an education in the 'pathology of the living' which most of his predecessors lacked, and which even some of his critics have failed to take advantage of in their own education. Most abdominal operators in Casualty Clearing Stations during the war learnt to do what Lane had done for years: this makes for avoidance of trauma and shock. If one analyses one's experience of tragedies witnessed in abdominal surgery, they owe seventy-five per cent of their difficulty to too small an incision.

2. Speed. Lane does not strike the casual observer as a rapid operator, yet the colon is often removed, ileocolostomy performed, and the peritoneal cavity closed, well within an hour; this is possible owing to every act being purposeful, and an entire absence of haste.

3. After end-to-side ileocolostomy had failed, and even a secondary colectomy combined with this method of anastomosis failed to obviate the objectionable regurgitation into the blind colon and its enormous dilatation, Lane made a real advance in intestinal surgery which may have a very wide application, when he showed that the small may be joined to the large bowel without risk by an end-to-end anastomosis; this is the method he has adopted for some years, and, following his example, many surgeons have realized that axial anastomoses of the large bowel possess no special risks when the technique of their performance is based on sound surgical principles.

4. Lastly, there are two points of greater importance than is at first apparent:—The first is the use of continuous axillary saline during and subsequent to the operation. Lane holds that this minimizes shock (and certainly the pulse-charts of a series of

colectomies support this idea), and also by maintaining the blood-pressure diminishes post-anæsthetic vomiting. The second is the insertion of a rectal tube through the anus to a point in the ileum well above the anastomosis, with the object of preventing flatulent distention in the region of the anastomosis.

On the last occasion on which I saw him work, Lane had to deal with a small infant with a single harelip and palate cleft ; the hard palate was closed by Lane's flap method, the mucoperiosteal flap on the side of the cleft being turned over, hingeing on its mesial border, and that covering the half of the palate to which the vomer was attached being swung inwards with a hinge behind so as to cover the first flap. In turning over the hinged flap care is taken to preserve the descending palatine vessels.

The soft palate was left for a second operation, and the lip was sutured. Adhesions between the lip and gum is one of the worst features of an unsatisfactory operation, and to avoid this Lane makes use of the margins of the harelip in the following way :—The margins are incised from the anterior surface through about three-quarters of their thickness just outside the junction of the pink mucosa and skin ; the flaps so formed are turned backwards and everted ; they are retained in this position by catgut mattress sutures, bringing the raw surfaces into apposition ; this ensures an abundant mucous covering to the deep surface of the lip and also increases the thickness of the opposed raw surfaces. The two raw edges of the cleft are then brought together with a buried continuous catgut suture, and the skin with interrupted sutures of gossamer gut.

In the writer's opinion the flap operation has a very definite field in the closure of clefts of the hard palate for cases for which no adequate alternative exists ; this view may not be generally accepted, but it must be admitted that Lane's ingenuity and writings on this branch of surgery have favourably influenced the practice of most of those interested in such cases, in that they now operate at a much earlier date, so that, as Lane pointed out, the normal conditions of nasal respiration are established, and therefore the nasal cavity is, at as early a date as possible, brought under influences which favour its normal growth and function.

Most of the visitors to Lane's clinic have listened to his exposition of his views on surgical conditions which were engaging his interest at the time ; these were always expressed with characteristic originality of view-point and with an almost mesmeric enthusiasm ; thus it will be readily understood that all the best of the senior students at Guy's have been attracted to his 'firm' as house surgeons ; but to the multitude he did not appeal as a teacher for, in the ordinary sense, he had no command of 'the spoken word,' and indeed never concealed the fact that the majority of conditions which fill the surgical beds of the large hospitals had no interest for him, so that for some time his hospital practice has been almost entirely confined to abdominal surgery, operations on fractures, and cleft palates.

There is much to be said for this attitude provided it is not generalized to the whole surgical staff. Lane has the true researcher's mentality and originality, and, quite apart from his many original observations and methods, his influence on the practice and surgical outlook of his juniors at Guy's, which has been vastly greater than that of any of his contemporaries in the last thirty years, will exist for many years to come, and is perhaps one of his chief causes for self-satisfaction.

Of the present staff at Guy's, nine engaged in general or special surgery have worked under him as house surgeons, and without doubt each of them would attribute all his knowledge of surgical cleanliness, and a very large proportion of his technical skill, to Lane's practice and example.

A VISIT TO THE CLINIC OF PROFESSOR HENRI HARTMANN, AT THE HÔTEL DIEU, PARIS, JULY, 1920.

A SMALL, well-built, swarthy-complexioned man, with hair and beard once jet black but now more than grizzled, is Henri Hartmann, Professor of Clinical Surgery in the University of Paris, and Surgeon to the Paris Hospitals. Formerly attached to the Lariboisière Hospital when he was but an *agrégé* he has now for the last nineteen years served the

FIG. 158.—Showing Professor Hartmann in the operating theatre with his three assistants, Drs. Bergeret, Gouverneur, and Huet.

Hôtel Dieu, that hospital on the banks of the Seine which, from time immemorial, has been under the shadow of the great cathedral of Notre Dame, in the very heart of the city, in much the same way that St. Bartholomew's Hospital in London has always been overshadowed by St. Paul's.

Hartmann is well known as a pioneer in abdominal surgery. His early work on the

stomach was done in collaboration with his master, Prof. Terrier, whilst that on the rectum was published with Prof. E. Quénu. As early as 1901 he published a valuable course of lectures on *Gastro-intestinal Surgery*, and in 1913 he was selected to receive the Honorary Fellowship of the Royal College of Surgeons of England. Like the rest of his surgical colleagues in Paris, he welcomed all members of the International Society of Surgery to his operating theatre, and willingly showed them his wards, laboratories, and teaching apparatus. Accordingly, on a blazing July morning a considerable number of English, American, Danish, Swedish, and French provincial surgeons assembled at the Hôtel Dieu and watched him perform: (1) A total hysterectomy with removal of both ovaries, one of which was converted into a large ovarian cyst; (2) A cholecystectomy for gall-stones; (3) Excision of a gastric ulcer situated upon the lesser curvature. The operations were timed to begin at 9.30 a.m., and five minutes before the time the Professor was stripped and was systematically scrubbing his hands under running water. Punctually to time the patient was placed upon the operating table, having been anæsthetized in a small room adjoining the theatre. The transference from the trolley to the table was effected by a single porter, who lifted the patient knees and shoulders together, and so removed him when the operation was finished. The surgeon, with one assistant, was wearing a sterilized short-sleeved gown, with cap and mask, and a pair of rubber gloves, thicker than those used in England and reaching to the middle of the forearm. The sister in attendance was dressed more coquettishly than would have been allowed by the matron of a British hospital, with high-heeled white shoes, but she was quiet, alert, and evidently skilled in her duties. She wore no gloves, and took no part in the operation except to hand such things as were needed by means of a pair of duck-bill forceps. The instruments were taken straight from the sterilizer and laid upon a dry towel; the only lotion used was a bowl of sublimate for the surgeon's hands. No students were present, though there was ample space railed off for them in the theatre. No shoes were changed nor goloshes worn, but a gown was provided for each spectator.

Each operation was performed rapidly, but without hurry. The hysterectomy, which included the tapping of a large ovarian cyst, began at 9.35, and the patient left the table at 10.13; the cholecystectomy commenced at 10.20, and was completed at 10.43; the operation for gastric ulcer began at 10.52, and the last suture was tied at 11.35. Each operation was carried out through a large incision, oblique and along the lower border of the ribs in the case of removal of the gall-bladder and exploration of the stomach. The hæmostases were remarkably complete, owing to the care with which the main vessels were ligatured before the branches were divided. This appears to be a feature of French surgery, for there was the same conservation of blood in the operations of other surgeons. Sterilized catgut was used for the ligatures and for suturing the peritoneum: chromicized for the abdominal walls. Silk was employed for the stomach sutures. The cholecystectomy wound was closed in three tiers, but the abdominal wound on the left side was closed with only a single row of sutures passing through the skin and the whole thickness of the muscle and peritoneum. The skin was brought together by silkworm-gut sutures inserted with a Reverdin's needle, the sutures being reinforced with Michel's clips. Each wound was drained by means of a large rubber tube; a dressing of white gauze and wool was applied, and was kept in place by a binder. The anæsthesia was complete during the operation, but the patient was recovering before the trolley left the theatre.

Adjacent to the theatre is a library and a small museum, both personal to the Professor. The rough notes of each case are written by a student, but Prof. Hartmann stated that the detailed account of each operation is written by himself. Each set of notes is numbered serially. The present number is nineteen thousand odd, and as Prof. Hartmann is now in the nineteenth year of office it is clear that the average number of operations which he performs is one thousand a year from a service of 140 beds. In like manner the museum contains the specimens he has removed, which are numbered like the notes, so that there should be no difficulty in obtaining quickly the history and clinical details of each preparation.

The Hôtel Dieu was rebuilt unfortunately between 1868 and 1878, before the principles of modern hospital construction were understood. The wards, therefore, are too massive, and are somewhat deficient in light and ventilation as judged by modern standards. The patients looked well, and the temperature charts showed that the operations ran an aseptic course. A stone balcony runs along the whole length of the wards, and on it, we were told, the beds could be wheeled on fine days.

At the end of the wards is a room devoted to books, and in this room Prof. Hartmann has gathered together a large number of pamphlets arranged in loose covers and labelled according to their subjects. It is thus possible for a student to consult the most recent literature on topics which interest him. Attached to the clinic is a pathological department especially devoted to the study of cancer.

It would thus appear that at the present time in Paris the surgical services are decentralized as far as possible. The office of surgeon to the Hôtel Dieu, as in England, is a part-time office, but the clinic is complete in itself, and not, as with us, a part of a central institution, because the notes, the pathological specimens, and the library are directly under the control of Prof. Hartmann.

SHORT NOTES OF RARE OR OBSCURE CASES.

GUNSHOT WOUND OF FOREARM MASKING SYMPTOMS OF CERVICAL RIB.

By C. P. G. WAKELEY, London.

A. P., a pensioner, age 25, was sent from the Pensions' Board for massage and electrical treatment to the Pensioners' Clinic at King's College Hospital in July, 1920, with an old gunshot wound of the right forearm.

He gave the following history. He was wounded in the right forearm in June, 1918, a piece of shrapnel entering about three inches below the elbow and lodging between the radius and ulna. The wound healed well and the metallic fragment was left *in situ*.

Fig. 159.

Fig. 160.

The patient was ordered massage treatment when the wound had healed, and, owing to some loss of power in his grip, had continued massage at various hospitals for the last two years. He was not getting any better; if anything, he considered that his grip was gradually becoming less.

On examining the patient, a well-built man, the muscles of the right forearm were in excellent condition. There was a small entrance wound in the centre of the forearm

which had healed without any scarring. There was some wasting of the intrinsic muscles of the hand, especially the first dorsal interosseous. An *x*-ray photograph of the forearm (*Fig.* 159) demonstrated one large and two small pieces of metal between the radius and ulna, there being no abnormality of the bones. The clinical condition did not correspond to a lesion of the ulnar nerve.

Owing to the wasting of the first dorsal interosseous it was decided to have a skiagram taken of the cervical spine to see if there was any trace of a cervical rib, although such a condition could not be ascertained clinically, and nothing abnormal could be palpated in the neck. The skiagram showed that cervical ribs were present on both sides, that on the right being the larger (*Fig.* 160). It is a curious fact that cervical ribs do not give rise to symptoms until between the ages of 20 and 30 years. Tubby[1] states that in 29 cases of cervical rib the average age when attention was drawn to the condition was 27 years. But following the introduction of *x*-ray examinations cases are now diagnosed earlier. Tubby operated on a child 2 years old. In the above case the disability was not due to military service, and the patient should not be drawing a pension.

It is interesting to note that this man's sister had bilateral cervical ribs which did not cause any symptoms until she was 23 years of age. Excision was performed on both sides, with a good result.

REFERENCE.

[1] *Deformities*, Macmillan & Co.

INTUSSUSCEPTION OF THE VERMIFORM APPENDIX.

By A. J. BLAXLAND, Norwich.

Intussusception of the appendix in an adult is a very rare condition, and only a few cases have been recorded. One case of partial intussusception in a woman of 50 was recorded by M'Connell and Wilson in this journal in April, 1914, and another case of complete inversion in a man of 60 was recorded by Burghard in the same number.

The case that I record is that of a man of 63. The appendix had become completely turned inside out and had drawn the bowel up with it, resulting in an ileocolic intussusception—the commonest variety according to Mosehowitz.[1]

The history of this case suggests that the invagination of the appendix took place gradually over a period of several weeks, and caused no symptoms of consequence until the cæcum became implicated in the process, when acute symptoms at once became evident. In the absence of the passage of blood per rectum, the cause of the intestinal obstruction could not be diagnosed prior to operation, but the detection of the abdominal tumour enabled the selection of the most suitable incision for laparotomy to be made.

The patient, a man 63 years of age, was sent to the Norfolk and Norwich Hospital on April 3, 1920, by Dr. Sturdee, of Walsingham. He had had 'grumbling' pain in the right side of the abdomen for six weeks; two days before admission to the hospital the pain had been acute and he had vomited frequently. Enemata had been given without result.

On admission the patient looked very ill; the temperature and pulse were subnormal. The abdomen was moderately distended, and there was some general rigidity. An indefinite tender lump could be felt under the middle of the right rectus. Rectal examination revealed nothing abnormal. There was no blood on the examining finger.

A couple of hours later an exploratory laparotomy through the right rectus at once revealed the presence of an intussusception. The apex of the intussusceptum lay in the middle of the transverse colon. It was freely movable, about the size of a man's thumb, and consisted of the appendix completely invaginated.

The cæcum, the lower half of the ascending colon, and a portion of the ileum, which formed the proximal part of the intussusceptum, were reduced by manipulation without

much difficulty, in spite of considerable œdema of the cæcum. On the inner and lower aspect of the cæcum could then be seen a dimple corresponding in situation to the base of the appendix, and this organ, inverted and much thickened, could be felt easily, lying in the cæcum.

As it was obvious that further manipulation would be useless, an incision was made into the cæcum on its outer wall and was carried around the root of the appendix, which was thus removed. The opening into the cæcum was closed with a double layer of silk sutures, and the laparotomy wound closed.

Except for an attack of gouty arthritis in both ankles a week after the operation, the patient made an uneventful recovery and returned home on April 23.

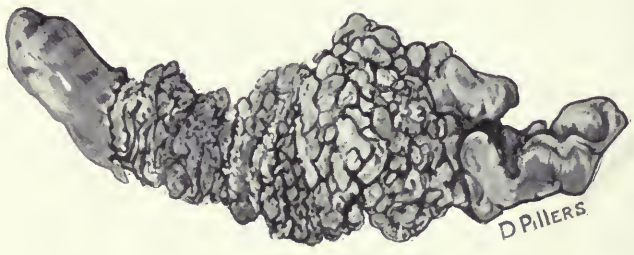


FIG. 161.—Intussusception of vermiform appendix. ($\frac{3}{4}$ natural size.)

On examining the specimen removed, it was seen to be a completely inverted appendix. It was over 4 in. long, and $1\frac{1}{2}$ in. wide at its base. The terminal inch was smooth, white, and bloodless. The mucous membrane over the rest of the organ was the seat of extensive soft papillomatous growth, most evident at the cæcal orifice. The base of the appendix was surrounded for a quarter of an inch by healthy cæcal wall.

A microscopical section of the growth was prepared, and Dr. Claridge, hon. pathologist to the hospital, reports it to be a malignant papilloma.

This case illustrates the fact that malignant growths of the appendix are prone to cause symptoms at an early stage, before lymphatic infection has become manifest. To this fact is attributed the relative freedom from recurrence after removal of a malignant appendix,[2] and this appears to me to be a plausible explanation.

REFERENCES.

[1] MOSCHOWITZ, "Intussusception of the Appendix", *Med. Record*, 1910, Dec. 17.
[2] *Keen's Surgery*, vi, 579.

OMPHALOMESENTERIC CYST CAUSING INTUSSUSCEPTION.

BY F. J. COUTTS, LONDON.

IN the BRITISH JOURNAL OF SURGERY, Vol. III, p. 145, there is a short note of an omphalomesenteric cyst causing acute intestinal obstruction; and in Vol. VIII, page 136, a case is reported of inflammation of Meckel's diverticulum simulating acute appendicitis. In the first case small cysts were also present in the abdominal wall, and in the second a cyst was found just behind the umbilicus but connected with the diverticulum.

The two cases recorded below were admitted to hospital within six weeks of each other.

The first, a boy, age 4, was sent in as a case of acute appendicitis. The symptoms did not suggest this common ailment, but rather intussusception, and after an enema had been given this opinion was strengthened by blood-stained mucus coming away in the wash-out. There was some resistance and tenderness in the right iliac region. Under

anæsthesia, a tumour was felt on the right side of the abdomen. The abdomen was opened to the right of the middle line, and the tumour was found to be an intussusception of the ileum into the cæcum and ascending colon. The reduction was easy, and towards the end of the reduction a projection was seen to bud out of the ileum, and on further manipulation a full-blown Meckel's diverticulum about three inches long was extruded. There was no mesentery.

The base of the diverticulum was clamped, ligatured, and cut off. The stump was inverted, and the operation terminated by closing the abdominal wound. The child made an uneventful recovery. Such cases have been recorded.

The second case, a boy, age 10 months, was taken with severe pain accompanied by vomiting on June 3, 1920, in the evening. Next day the pain was intermittent and there was less vomiting, but in the afternoon pain again became more frequent and vomiting restarted. The child was admitted to hospital about 10 p.m., June 4, with the diagnosis of intussusception.

Under the anæsthetic, the tumour was felt above and to the left of the umbilicus. The abdomen was opened to the right of the mid-line. The tumour was brought to the surface, and the first thing noticed was the tip of the appendix vermiformis projecting from the neck of the intussusception. The apex felt very hard, and suggested a fibroma in the small intestine. Reduction was easy except the last few inches, but with continuous pressure a cyst showed itself, and on further expulsion the peritoneal coat over the cyst cracked. The peritoneum and muscular fibres over the cyst were drawn aside, and with a dry gauze swab the cyst was enucleated from its bed—the flaccid mucous membrane of the bowel. There was no stalk into the bowel. The peritoneum was stitched over the raw area and the abdomen closed.

That night the child passed a good motion, and two more the following morning. Unfortunately the chest gave trouble and the child died from bronchopneumonia. The cyst was about two inches in diameter and contained clear fluid ; it was not opened.

The interesting question was, from what structure did the cyst arise ? From its position within a few inches of the ileocæcal valve it suggested the Meckel's diverticulum, and in this case apparently the umbilical and bowel connections had both become obliterated and left this cyst sessile on the bowel. I can find no reference to any such case.

REVIEWS AND NOTICES OF BOOKS.

Diseases of the Rectum. By Louis J. Hirschman, M.D., F.A.C.S. Large 8vo. Pp. 378, with 223 illustrations and 4 coloured plates. Third edition, revised and rewritten. 1920. London: Henry Kimpton. 30s. net.

The War produced no opportunities for advancement in general rectal surgery, and this edition, except for about forty additional illustrations, does not differ materially from the second.

Many of the plates, taken from photographs and illustrating operative technique, fail to give a clear idea of the methods employed; the hands of the surgeons and the instruments seem to fill most of the picture. Some of the best illustrations are to be found in the radiographs of diseases of the large intestine.

The author deals very fully with the method of examination and the use of instruments, and in the main we are in agreement with his views, though we have not found the inverted or Hane's position necessary in proctoscopy.

Constipation and obstipation are considered at length, and freely illustrated with radiographs. The author's method of curing chronic constipation by the use of a rubber dilating rectal-massage bag is worth a trial, in view of the successes which he claims.

Pruritus ani is carefully considered. and we find the usual plethora of prescriptions for treating the local dermatitis. The value of zinc ionization, and in some cases of *x* rays and radium, in clearing up local dermatitis is not referred to.

We are pleased to note that hypertrophy of the papillæ of Morgagni is mentioned and the pathological results discussed. The part which these small bodies play at the anorectal junction has been too long neglected by text-books.

Many text-book articles on rectal surgery fail, as does this volume, to draw attention to the great advantage of opening an ischiorectal abscess so that the mouth is 3- or 4-sided and not a mere slit, i.e., by a T-shaped or + incision followed by excision of the overhanging skin-flaps, to facilitate drainage and healing.

In the chapter on fistula, the author makes use of bismuth and radiography as an aid to diagnosis. We believe there is nothing to be gained by this method, and that results may be misleading. Induration felt under the finger is usually the best guide to the track of a fistula, and a probe causing pain is seldom required for purposes of diagnosis.

Throughout the book the author is a strong advocate of local anæsthesia, which he finds satisfactory even for ligature of internal hæmorrhoids. There is no doubt a tendency in this country not to use local anæsthesia with sufficient frequency, especially in anorectal complaints, but we confess to not being satisfied with its employment for ligature of hæmorrhoids.

The clamp and cautery method of treatment is condemned; we, however, have found this operation ideal as regards freedom from pain after operation and rapidity of recovery; but it is necessary to employ careful technique, and all cases are not suitable.

The frontispiece, an excellent coloured plate, illustrating a carcinoma of the rectum above and a plexus of hæmorrhoids below, stimulated us to turn with interest to the chapter on carcinoma. With some surprise we find only sixty-five lines devoted to cancer of the rectum, which appear in the chapter on the limitations of local anæsthesia. No less than forty pages are allotted to an article on dysentery by Dr. John L. Jelks. Some thirty pages at the end of the volume, devoted to clinical examination of the fæces, might well have been allotted to the most serious and most distressing of all diseases of the rectum.

Selected Lectures and Essays. By Sir John Bland-Sutton, F.R.C.S. Eng. 8vo. Pp. xi + 320, illustrated. London: William Heinemann (Medical Books) Ltd. 15s. net.

These selected lectures and essays shed much light upon the complex character of Sir John Bland-Sutton, and give many indications of the means by which he has attained the distinguished position he now holds in the world of science. The book as a whole is so full of personal vestigia that it is easy to reconstruct his life-history. In the dawn of his intelligence there was a primæval love of morphology, coupled with the insatiable curiosity of 'the elephant's child' spoken of by Rudyard Kipling in his *Just So Stories*. These primæval affections led him to study comparative anatomy—not in books as a German would have done, but—being a Londoner—at the Zoological Gardens and the Royal Veterinary College in Camden Town. Doubtless, too, the

res angusta domi made him a teacher of anatomy in the medical schools, and he was thus able to generalize on human anatomy to the enlargement of its boundaries and the advantage of his pupils. Hence came his essays on *Ligaments*, written in 1887, and now published as a fourth edition nearly a quarter of a century afterwards. These essays are twelve in number, and shed much light on various recondite anatomical problems. For the most part credit is given where credit is due, for a short bibliography is appended to each essay. By some mischance there is no reference to the work of William Kitchen Parker, who in many respects was the very spit or marrow of Sir John Bland-Sutton himself, a modest, plodding, Bible-loving practitioner of medicine, whose work on the shoulder-girdle deserves the most ample acknowledgement. At this period Sir John had not yet come to his own; the material is good, but he had not attained the facility in writing which he afterwards reached. His quaintness of expression, however, existed, as is shown in the statements that " the story of the guinea-pig's symphyseal ligament emphasizes the disadvantages which offspring with big heads entail on their mother," and " the flippers of whales, like the wings of penguins, resemble hands in mittens." The essays may be taken to represent the eozoic age in his mental development; the mesozoic period shows the author no longer following pure science, but turning his knowledge to account as a skilled hospital surgeon. In this aspect he discourses of pins in the vermiform appendix; of the expectation of life after operation for stone in the kidney; of jejunal ulcers; of the surgery of the heart and of missiles as emboli. The rapid march of surgery is well shown by reading the essay on wounds of the heart. Sir John —writing in 1910—estimates the mortality after operation in these cases to be 65 per cent, and makes no mention of the bundle of His. Tuffier, in 1920, gives the mortality as 50 to 55 per cent, and is able to quote innumerable cases. There is evidence in this mesozoic period that Sir John was directing special attention to gynæcology, for there are essays on tubal and abdominal pregnancy, and in this connection it would be of interest to know the difference between a harlot and a courtesan, for he states that in his experience tubal pregnancy is not common " in a harlot or a courtesan." The gynæcological lectures are full of interest, for they show the practical value of a knowledge of embryology and comparative anatomy.

Several of the remaining essays are of the nature of journalism, and are letters contributed to the *Morning Post*, telling of the bull-ring and of his experiences with a convoy in the North Atlantic during the War. Excellent reading, and showing that curiosity is still as predominant a feature in the author as it has always been. Lastly, in the series of chapters on " Medicine of the Bible," we learn that he has a sound working knowledge of the Old Testament and that he has travelled in the East, for he illustrates many of his remarks by first-hand knowledge of customs still prevailing there. Incidentally, too, we learn that he belongs to the Church of England, but as he accepts without demur the numbers which are so fallacious in the original, there is no evidence that he has studied the Scriptures in the original tongue.

The essays are all worth reading, not only for their intrinsic value, but on account of the interesting manner in which the information is conveyed, whilst the high reputation of the author is enhanced by their publication in this collected form. They are dedicated appropriately to the old students of the Middlesex Hospital Medical School. A word of praise must be given to the numerous illustrations, many of which have been drawn by Mr. C. Berjeau, the blocks being cut by Butterworth. They show the advantage possessed by woodcuts over process blocks for the illustration of pathological processes.

Surgical Shock and the Shockless Operation through Anoci-Association. By George W. Crile, M.D., Professor of Surgery, and William E. Lower, M.D., Associate Professor of Genito-urinary Surgery, Western Reserve University. 8vo. Pp. 272, illustrated. 1920. London: W. B. Saunders. 21s. net.

This is the second edition of *Anoci-Association*, and is thoroughly revised and rewritten. Much additional matter, obtained from civilian and military experience corroborative of the soundness of the fundamental principles of anoci-association, is incorporated.

There is a short introduction on the evolution of the theory of shock and the shockless operation, followed by a chapter on the author's well-known kinetic theory of shock. The cause and pathology of surgical shock are then fully discussed, and beautifully illustrated by photo-micrographs showing the effects upon the cells of the brain, liver, and adrenals of exhaustive stimulation and the restorative effects of sleep. The subject is treated in a concise and lucid manner, and it is clearly demonstrated that the complete exclusion of both traumatic and emotional stimuli will wholly prevent the shock of surgical operations.

After briefly surveying the clinical phenomena, the authors proceed to describe treatment. This is essentially a practical application based on the principles laid down in the previous parts of the book. Every surgeon will agree that it is easier to prevent than to cure shock, and the method of prevention is described in thirteen chapters, each one detailing the necessary measures to be applied to a particular region of the body, and terminating with a few useful and pithy 'Dont's'.

Anyone who has practised the anoci-association technique will be in full agreement with the authors when they contend that it is not always necessary, but to be able to perform it efficiently

when it is required it is essential that it should be always applied. There are so many points where a break may occur, not only in the surgeon's work, but in that of any one of his team, that it is necessary to be always utilizing it, so that it may become as automatic as is the case with a thoroughly aseptic technique.

Great stress is laid upon the beneficial effects of morphia at all times, in the absence of cyanosis: this symptom indicating, in the authors' opinion, a state of acidosis, in which it is dangerous to give morphia, as it then impedes the efforts of the body cells to rectify the medium.

Chapter XXI sets out the technique, physiological effects, and dangers of blood transfusion, and gives a short description of the blood groups. The authors are quite satisfied of the great usefulness of this method of treatment in shock.

Chapter XXII deals with anæsthesia, and shows how the general anæsthetics, with the exception of nitrous-oxide oxygen, fail to protect the central nervous system against the exhausting effects of harmful stimulation.

The authors contend that the practical value of anoci-association is attested by the fact that in their clinic both the mortality and post-operative morbidity have been reduced by the application of the principles, and by the fact that, when tested on an enormous scale in the vast surgical theatres of the War, the principles of anoci-association have been clearly sustained.

This is undoubtedly a book which all surgeons who desire to do the utmost for their patients should acquire, read, mark, learn, and inwardly digest. Like most of Crile's work, it is based on extensive and elaborate experimentation; and though everyone may not agree with his theories, there can be no doubt about the soundness of the application of an efficient anociation in practical surgery. The book is well got up, the type is good and clear, the plates are beautiful, and there is a full index attached.

Plastic Surgery of the Face. Based on Selected Cases of War Injuries of the Face, including Burns. By Major H. D. Gillies, C.B.E., F.R.C.S., with chapters on Prosthetic Problems of Plastic Surgery by Captain Kelsey Fry, and on Anæsthetics by Captain R. Wade. Large 4to. Pp. xii + 408. With original illustrations. 1920. London: Oxford Medical Publications. £3 3s. net.

This is a handsomely-illustrated volume recording the results of plastic surgery used to restore the disfigured faces of wounded soldiers. In the first years of the War this work was largely neglected; the methods in use were meagre and antiquated, and had not kept pace with the advances in general surgery. The result was that many wounded men were left with scars and horrible deformities which were grievous and crippling to themselves and distressing to all who saw them. The work of Major Gillies and his coadjutors has to a great extent remedied this lack, and the principles and technique of the art of plastic surgery have been put on a sound basis. The work has been bold in conception, and carried out with the skill and indomitable patience which this branch of surgery demands.

There are two main points which strike one on reading this book. Firstly, plastic surgery, if it is to be successful, must restore function as well as looks. In the past it has been largely cosmetic. In this book it is shown that the restoration of a nose must be associated with an efficient air-way, and a graft, to remain of use, must be exercised. The second point is one of technique, and is concerned with the formation of flaps. The subject of the fashioning of flaps figures very largely, and it seems that a great advance has been made in the method of forming tubular flaps, by which means skin can be removed from comparatively long distances to cover defects.

Incidentally, much light has been thrown on the whole question of the life of grafts, both of skin, bone, and cartilage, their resistance, capability of life, and independent growth.

It seems likely that the methods here detailed may have an important bearing on the future surgery of scars, disfiguring tumours, and deformities.

Las Amputaciones Cineplasticas (Kineplastic Amputations). By Dr. Guillermo Bosch Arana. Demy 8vo. Pp. 352, with 194 illustrations. 1920. Buenos Aires: *La Semana Medica*, Imp. de Obras de Emilio Spinelli.

Notwithstanding the fact that kineplastic amputations were proposed by Vanghetti in 1898, and have been performed in increasing numbers since Ceci's first reported operation in 1905, we fear that it cannot yet be said that the proceeding has established for itself a permanent position in practical surgery. There have been hundreds of publications on this subject, and many operations have been performed, especially in Italy and Germany, and we may safely say that we are now in possession of enough experience to establish a satisfactory operative technique. Good plastic motors can be produced, but there has been and still is great difficulty in adapting to them strong and useful prostheses.

Professor Bosch Arana, of Buenos Aires, has made kineplastic stumps in twenty cases, and has given us full details of them in the work now under notice, together with a valuable review

of the whole subject. In the first place it is noticeable that, unlike most series of kineplastic amputations, this one consists of civilian cases, and that the majority affect the lower extremity, with which European surgeons have not as yet been extensively concerned, and that seven cases were primary kineplastic amputations.

Only five of the twenty cases have been satisfactorily fitted with apparatus, and it is most significant that only one of these is an amputation of the upper extremity. This fact bears out European experience of the great difficulty of devising and applying a satisfactory artificial arm for a kinematized stump.

One case of amputation in the upper third of the femur is justly claimed by Dr. Bosch Arana as unique in the world's literature. Amputation was performed on account of hydatid disease of the bone. The superfluity of skin made the covering of the motors easy. Despite the high site of the bone section, the whole of the thigh muscles were preserved and used, forming one extensor club (clava) motor containing the patella, and one flexor loop (ansa) motor containing the hamstring muscles. The result is reported as 'admirable'.

Dr. Bosch Arana, like many other surgeons, does not favour the tunnel motor, so much in favour in Germany. He prefers the loop, and occasionally, as in the last case, the loop accompanied by the club motor. He thinks that at present two is the maximum number of motors that can be used, but does not despair with improved apparatus of making use of three.

This book contains a good history of the subject, and descriptions and diagrams of various artificial hands, and also of the ergograph devised by the author. It is, however, deficient in representations of artificial legs, particularly those found useful for the four successful lower-limb cases. It is just on this point that more light and full details are needed by surgeons and limb makers.

We welcome this book as a candid scientific statement of the case; and although it is written in the Spanish tongue, the numerous illustrations and the table of cases make it worth the study of those who have no knowledge of that language.

Diathermy in Medical and Surgical Practice. By Claude Saberton, M.D. Pp. xii + 138, illustrated. 1920. London: Cassell & Co., Ltd. 7s. 6d. net.

This book forms one of the series of 'Modern Methods of Treatment,' and is intended as a guide to students and practitioners who wish to master the technique of diathermy, and to understand its place in the treatment of diseases.

The book is divided into three parts. In the first are described the apparatus used, the physical and physiological effects of diathermic currents, and the methods of application. These points are discussed very fully and in considerable detail, and illustrations are employed which help materially in the understanding of an apparatus which at first acquaintance appears to have a very complex design. Under physiological effects the author points out that, while these appear to be mainly brought about by the heating of the tissues, this is not necessarily the only beneficial action of high-frequency currents.

In the second part of the book the effects of diathermy are discussed from the medical aspect in the treatment of some diseases of the circulatory and nervous systems, of fibrositis, scars, adhesions, and diseases of joints, of thoracic and other affections. In all these conditions the endeavour is to raise the temperature of the tissues within physiological limits, whereas in surgical affections, which are discoursed upon in the third part, this limit is intentionally exceeded and the tissues destroyed. The author has had a large experience with diathermy and speaks very confidently of its excellent qualities.

The surgical affections which are particularly mentioned are: superficial lesions, as nævi, moles, acne, etc.; papillomata of skin and mucous membranes; malignant growths, especially those of the mouth and nasopharynx; various inoperable growths; papillomata of the bladder; vascular tumours; and rodent ulcer.

The advantages and disadvantages are tabulated, and the technique is fully described. There is quite an extensive bibliography appended and a sufficient index. The book is essentially a practical one, and amply fulfils the purpose for which it is intended.

Surgical Treatment: a Practical Treatise on the Therapy of Surgical Diseases; for the Practitioners and Students of Surgery. By James Peter Warbasse, M.D., F.A.C.S. Three volumes. Vol. II, pp. 829, figures 759, and Vol. III, pp. 861, figures 865. 1919. London and Philadelphia: W. B. Saunders & Co. £7 7s. 0d. net.

This system of surgical treatment, the first volume of which was reviewed in an earlier issue, has fully come up to its promise of completeness and exactitude.

In the first of the two volumes under present review the following subjects are dealt with systematically: injuries and diseases of the head, the eye, the nose, the larynx and trachea, the mouth, ear, spine, neck, thorax, and abdomen. The scope, therefore, of this volume covers

the principal domain of operative surgery. The chapters on head surgery give a good account of different methods of hæmostasis and of craniotomy in exposure of the brain; but the scope of the work naturally precludes any discussion as to the details of the diagnosis of cerebral conditions. The surgery of the eye occupies about sixty pages, and the question naturally arises whether it is possible to cover the ground adequately in this short account; possibly the same criticisms would apply to the sections on the other less defined surgical specialities, namely the ear, nose, and throat.

It is rather remarkable that in the sections dealing with cleft palate the method of Brophy should not have one single illustration. It is described in one paragraph, after which occurs the following curt statement, "This operation was once very popular. Now, those most in favour with surgeons doing much of this work are the sliding-flap operations."

As in so many works of this kind, the space given to rare conditions is quite out of proportion to their importance. For example, there are more space and illustrations devoted to deformities of the lower jaw than to the important subject of carcinoma of the tongue.

The surgery of the chest is described very much as it might have been ten years ago, when it was considered that complicated questions of differential pressure dominated the problem of all operations involving the opening of the thorax.

In the treatment of cancer of the breast, the extent to which the skin is removed is greatly in excess of what is usual in this country, but no very clear rules are laid down indicating how extensive this removal should be. A considerable number of plastic devices are illustrated for making good the great loss of skin.

The chapters dealing with abdominal surgery follow very much the same lines as those of an ordinary book on operative surgery—that is to say, the various classical operations are clearly figured and well described.

The author has little to say in favour of the operative treatment of chronic intestinal stasis; it seems a pity that he has allowed himself to illustrate an impossible type of stricture of the colon just for the sake of allowing the artist to picture its perfect cure.

The last volume deals with hernia, the rectum and anus, the appendix, the liver and gall-bladder, kidneys, ureters, bladder, prostate, the male and female generative organs, the extremities, amputations, plastic and cosmetic surgery, first-aid to the injured, and surgical bandaging. The descriptions of the surgery of the liver and gall-bladder, together with the other abdominal subjects of this volume, are good, there being a very detailed account of the various methods of reconstruction of an injured bile-duct. The section on genito-urinary surgery contains a great deal of valuable information, with useful illustrations, but we venture to think that it is somewhat marred by the inclusion of obsolete operations and instruments, such as the prostatic punch (*Fig.* 1663), and the urethrotome of Otis (*Fig.* 1706); a disproportionate space is given to operations for malformations such as epispadias and hypospadias, whilst the modern operations for the excision of strictures of the urethra are barely mentioned. The sections on the extremities include a somewhat brief account of the treatment of deformities. The chapters on amputations are good because they describe the various methods of fashioning cineplastic stumps suitable for different sites.

The author of this large and important work is to be congratulated greatly on the general excellence of his achievement. While it is easy to criticize details in such a work, it would be extremely difficult to produce a better one. The printing and illustrations leave nothing to be desired, and we feel sure that it will not be very long before Dr. Warbasse has an opportunity of revising his work in the pages of another edition.

Fractured Femurs: their Treatment by Calliper Extension. By Brevet Lieut.-Colonel G. Pearson and J. Drummond, M.D. With Foreword by Colonel Sir H. M. W. Gray. Large 8vo. Illustrated. Pp. xii + 92. 1920. London: Oxford Medical Publications. 10s. 6d. net.

This little book represents the specialized work of the authors during the last few years of the war, and particularly during the time when they were in charge of a special military surgical hospital at Edmonton which was devoted chiefly to the care of gunshot fractures of the femur. The work is an excellent illustration of how much can be done by a good team of men whose attention is concentrated upon a single problem, when led by a man of judgement and enthusiasm. Pearson seems to have begun on the lines of Jones and Sinclair, and then he improved various details of apparatus and standardized a system of his own.

The chief features of his method are three in number, viz., the use of a special form of ice-tongs caliper for applying extension to the femur, a bed designed for the treatment of fractures, and provision for mobilization of the knee and ankle from the outset in all cases.

The calipers which grasp the femur are so designed that their points cannot penetrate the bone more than a given distance; in fact the authors claim that they do not penetrate at all. We must take leave to doubt this statement, as also the advantage of a caliper over a transfixion pin. In both, the danger of sepsis in an infected limb is the great drawback, and the caliper, in its seton action, its proximity to the knee-joint, and its penetration of the fascial planes of the thigh, is in

exactly the same position as the pin, with the additional drawback of being mobile. However, the fact remains that in a very large series of cases efficient extension was obtained by the calipers without evil result, though we attribute the latter fact to the care taken in general technique rather than to the virtue of the calipers as such.

The success which followed the systematic mobilization of the knee throughout the whole course of treatment is perhaps the most gratifying feature of the system.

The Course of Operative Surgery. By Professor Victor Schmieden. Translated by Arthur Turnbull, M.B., Ch.B. With Foreword by Professor Dr. A. Bier. Large 8vo. Second English edition. Pp. xx+350, with 436 figures. 1920. London: Baillière, Tindall & Cox. 26s. net.

This is an ordinary student's text-book of operative surgery, a guide to operations upon the dead subject. It does not include any account of even simple operations on special organs, such as the nose, eye, or uterus. We fail to find in its pages any cogent reason for its translation into English, even though it is introduced by a foreword by Professor Bier.

Die deutsche Chirurgie im Weltkrieg, 1914–1918. By A. Borchard and V. Schmieden. In two volumes. Pp. 938, with 487 illustrations. Second edition. 1920. Leipsic: Johann Barth. 102 Mks.

This German War Surgery, contributed to by thirty professors, and prefaced by two notices, the first written in 1917, "the third year of the great War", and the second in the autumn of 1919, when "the War has come to a sudden and unexpected end", is a work which claims our interest for more reasons than one. We look through its pages chiefly to find whether the problems which confronted us so lately have been experienced by those on the other side; how those problems have been solved; and whether the solution has been better than, or not so good as, our own.

The work is, however, a disappointing one. It is far too short to deal with the subject at all adequately, and such a large proportion of its pages is taken up with routine surgery that there is no adequate discussion of the essential difficulties of military surgery.

The best section of the first volume is that dealing with the anatomy of various gunshot wounds. In regard to practical matters of treatment, the following points may be noted in comparison with our own experiences. As regards the problem of wound infection and disinfection, the main reliance is placed upon early excision, drainage, and various methods of hyperæmia. Wright's methods, and also that of Carrel-Dakin, are mentioned with approbation; also a special turpentine derivative named 'vuzin' which, used in proportions of about one to ten thousand, has all the valuable properties claimed for every new antiseptic. There is no mention of the aniline-dye preparations. The use of plaster-of-Paris as a routine method of immobilization of wounded limbs is extolled. The section on the treatment of deformities is much too short to be of any value.

The second volume deals with special subjects in detail. Except for a few diagrams it is very sparsely illustrated. The sections which deal with the head, chest, and abdomen give a good general idea of the subjects treated, whilst those on the more specialized subjects, such as plastic surgery of the face and of the jaw, and also that dealing with individual fractures, are too short to be of much practical value.

Surgical Therapeutics and Operative Technique. By E. Doyen. English edition prepared by the Author, in collaboration with H. Spencer Brown. Vol. III, Regional Surgery. Roy. 8vo. Pp. x + 811, with 957 illustrations. 1920. London: Baillière, Tindall & Cox. 45s. net.

This third volume completes the English edition of the work. The long delay between the appearance of the first two volumes and the third was caused by the sudden death of the author, and the translator's absence on war duty. The present volume is a continuation from Vol. II on regional surgery, and is divided into two sections. The first deals with the surgery of the abdomen proper, and the author has incorporated a résumé of his researches into the physiology of the stomach and gastric digestion. The second part is devoted mainly to surgery of the female generative organs, and goes very fully into the operation of vaginal hysterectomy in particular. Operations on the genito-urinary system of the male are also dealt with. There are many excellent drawings and photographs taken from sections of the frozen body, which reveal most interesting anatomical relations.

This volume, like the previous two, is replete with instances of the originality and versatility of the author, and does not describe a variety of operations for any one condition, but those which the author himself practised, and in many cases originated. There is, however, in the volume

much to condemn ; this was not the case in the other two. Whilst reading the sections on the gall-bladder and stomach it is difficult to realize that these are appearing in a book published in 1920 ; they read like the surgery of twenty years ago.

There are, undoubtedly, some very good sections, but on the whole the volume is a poor one. Treatment is set out, as that which the author recommends, which surgeons of to-day would strongly condemn. As instances may be taken Doyen's practice of removing stones impacted in the cystic duct and suturing the gall-bladder subsequently ; also his custom was to employ marsupialization of the gall-bladder when the walls were so diseased as to render closure impossible or dangerous. The approach to the gall-bladder and the spleen recommended by him can only be considered as unwarrantably savage, involving, as it does, section of the 8th, 9th, and 10th costal cartilages, in the one case on the right side and in the other on the left.

Again, the section dealing with the stomach and duodenum is hopelessly out of date. It teaches that gastric ulcer is more common than duodenal ulcer, and that the diagnosis of the latter is more difficult than that of the former ; whereas in each case exactly the reverse is the view held by modern surgeons. Perhaps a qualification is necessary here, as Doyen was not alone amongst Continental surgeons in the views he held on these points. But we think that in 1920 all surgeons will agree that *x* rays are of great value in differentiating cancerous from non-cancerous affections of the stomach. *X*-ray specialists regard the filling defects seen in cancer of the stomach as conclusive evidence of the presence of this disease. Doyen, however, held a different opinion. Again, in the part of the volume dealing with stone in the kidney, Doyen barely mentions removal by incising the pelvis of the kidney ; he practically always incised the kidney itself. This is another instance of bygone surgery.

It would be tedious to multiply instances of this kind, all pointing to the same conclusion, that the third volume of the work, though published in 1920, really contains less surgery of this date than of that practised fifteen or twenty years ago.

As an exposition of the methods of Doyen this book is very good and well got up ; but it cannot be considered as a modern work on surgery in any sense.

PRESENTATION OF A GREAT MACE TO THE AMERICAN COLLEGE OF SURGEONS BY THE CONSULTING SURGEONS OF THE BRITISH ARMIES.

On Monday, October 11, 1920, in Montreal.

The Mace has been designed to tell in symbolic language of the close union between British and American Surgery, and of the ties which unite Great Britain to Canada and to the United States of America. It retains the traditional shape and proportions of the civic mace of the seventeenth century, and is of hand-wrought, chiselled and repoussé silver gilt. It has been designed and made by Mr. Omar Ramsden, who has also embodied some suggestions of Sir Berkeley G. A. Moynihan, K.C.M.G., and Sir D'Arcy Power, K.B.E.

The Dedicatory Inscription engraved on the plate under the Crown sets forth that it is a gift "From the Consulting Surgeons of the British Armies to the American College of Surgeons, in memory of mutual work and good-fellowship in the Great War, 1914–1918".

The Crown-shaped Finial is formed of six rich scroll buttresses upholding the "Sacred Flame of Science" issuing from a mortar of antique pattern, the model of which was recently found on the field of battle near Salonika. These buttresses spring from a cresting composed of alternating Maple Leaves and American Eagles intertwined with the Serpents of Æsculapius; while the position usually occupied by a band of jewels in a monarchal crown is filled with the words "The American College of Surgeons".

The Body or Head is divided into six panels by the Winged Caduceus being an ornamental rendering of the badge of the United States Army Medical Corps. The panels set forth the following "Achievements at Arms" in delicate and finely detailed repoussé work:—

1st. The full Blazon of the United States of America.

2nd. The Dominion of Canada.

3rd. The Royal College of Surgeons of England.

4th. The Badge of the Royal Army Medical Corps.

5th. The Shields of Arms of John Hunter and Lord Lister.

6th. A cartouche bearing the words "Philip Syng Physick, 1768–1837, Father of American Surgery".

The lower portion of the head is decorated with a symbolic band of water indicating the ocean which both unites and separates America and the Mother Country. The latter is symbolized by the British Lion brackets of highly chiselled work which support the head and terminate the upper part of the staff. The talons of the Lions' feet grip the hammered decoration of the upper knop, which consists of a design of American and Canadian maple seed-pods and heart-shaped spaces. This hammered work is protected by boldly-projecting, solid, jewel-like bosses of chiselled work.

The Staff is decorated with a free design of the national floral emblems of the United Kingdom—the Rose, the Thistle, the Shamrock, and the Leek. Intertwined among these are a number of ribbon scrolls, each of which bears the name of one of the donors.

The Foot bears, as decoration, the root form from which the above spring, and a series of six small shields which may be used for possible future armorial bearings, or inscriptions. The extreme bottom knop is fluted with leaves of *Isatis tinctoria*.

The various parts are held together, in the traditional manner, by a rod of English oak cut from a tree grown at Wytham, Berks. The extreme length is 3 ft. $11\frac{1}{8}$ in., and the weight of silver is 140 oz. troy.

THE CONSULTING SURGEONS OF THE BRITISH ARMIES WHO GAVE THE GREAT MACE TO THE AMERICAN COLLEGE OF SURGEONS.

Sir Charles Ballance, K.C.M.G., C.B.
Sir Hamilton Ballance, K.B.E., C.B.
Sir Gilbert Barling, Bt., C.B.
Seymour Barling, C.M.G.
Sir Anthony Bowlby, K.C.B., K.C.M.G., K.C.V.O., D.S.M.(U.S.A.)
Dr. P. H. A. Bruce
F. Burghard, C.B.
H. Burrows, C.B.E.
A. Carless, C.B.E.
Sir A. Chance, C.B.E.
C. C. Choyce, C.M.G., C.B.E.
Sir Kennedy Dalziel
R. Davies-Colley, C.M.G.
T. P. Dunhill, C.M.G.
Dr. J. M. Elder, C.M.G.
Sir Crisp English, K.C.M.G.
H. A. Fairbank, D.S.O.
C. H. S. Frankau, C.B.E., D.S.O.
Forbes Fraser, C.B.E.
Sir Peter Freyer, K.C.B.
A. Fullerton, C.B., C.M.G.
George Gask, C.M.G., D.S.O.
Sir Henry Gray, K.B.E., C.B.
Sir Robert Jones, K.B.E., C.B., D.S.M.(U.S.A.)
R. E. Kelly, C.B.
Sir Arbuthnot Lane, Bt., C.B.
Sir William Lister, K.C.M.G.
V. Warren Low, C.B.
Sir George Makins, G.C.M.G., C.B.
Sir Arthur Mayo-Robson, K.B.E., C.B., C.V.O.
A. B. Mitchell, O.B.E.
Sir Berkeley Moynihan, K.C.M.G., C.B.
Sir Thomas Myles, C.B.
T. H. Openshaw, C.B., C.M.G.
Colonel A. Pilcher, C.B., D.S.O.
Owen Richards, C.M.G., D.S.O.
Sir Hugh Rigby, K.C.V.O.
Percy Sargent, C.B., D.S.O.
James Sherren, C.B.E.
Maynard Smith, C.B.
Thomas Sinclair, C.B.
Sir Harold Stiles, K.B.E.
James Swain, C.B., C.B.E.
Sir Charters Symonds, K.B.E., C.B.
Sir William Taylor, K.B.E.
Sir John Lynn-Thomas, K.B.E., C.B.
Alexis Thomson, C.M.G.
Sir William Thorburn, K.B.E., C.B.
A. Tubby, C.B.
H. Wade, C.M.G., D.S.O.
Sir Cuthbert Wallace, K.C.M.G., C.B.
Sir Charles Gordon Watson, K.B.E., C.M.G.
A. Webb-Johnson, C.B.E., D.S.O.
Sir W. de C. Wheeler.

The Mace was taken to Montreal by Sir Berkeley Moynihan, Sir William Taylor, and Mr. Albert Carless, and the presentation was made by Sir Berkeley Moynihan, who said:—

"Three centuries ago, on this very day, a little sailing vessel, leaving England far behind her, was struggling against adverse winds and heavy seas towards America. On board were one hundred pilgrims fleeing from civil and religious tyranny to seek sanctuary and freedom in a new land. No voyage in history has been so fateful. Those who journeyed in that vessel, a chosen company on the horizon of your history, were the best of English stock. They helped to found here a small colony of people, grim and stoical in spirit, yet touched with idealism. Though all the great countries of the earth have since given of their best to build this nation, those few pilgrims have left their indelible stamp upon the culture, the institutions, and the laws of this land.

"Almost a century and a half ago that colony broke away from the Mother Country, with which it was long at war. But one hundred years of peace between the two nations had been celebrated when, in 1917, they stood together in arms. War is the Great Revealer. We learnt in that great testing time of our race that ties of blood, when they mean kinship in spirit and an equal surrender to the noblest impulse, are never to be broken. In the Great War America and the Empire mingled their blood upon the same stricken field. The hope then grew strong in many hearts that a new understanding born of comradeship in battle, fiercely tested in the furnace of affliction, and sealed in death, would redeem the ancient blunders, blot out the bitter memories of wrong, and lead at last to a supreme and permanent reconciliation. For we seemed then to realize that deep down in the hearts, enthroned in the conscience of the two peoples, there was the same full eager devotion to eternal principle, love of justice, joy in liberty, hatred of oppression; the same unselfish determination to strive for the redemption of mankind, and to establish anew the freedom of the world. On the fields of Flanders and of France, as in the cabin of the Mayflower, humanity recovered its rights.

"In the grave and anxious days of war, when we fought so long in fellowship,

THE GREAT MACE PRESENTED IN MONTREAL TO THE AMERICAN COLLEGE OF SURGEONS

BY THE CONSULTING SURGEONS OF THE BRITISH ARMIES ON OCTOBER 11, 1920

no associations were closer, no friendships more swift and intimate, no joint labours more fruitful than were those of the members of our profession coming from America and from every part of the British Empire. We then gained, each for the other, not respect and sympathy alone, but true affection also. Every lover of his country, every lover of humanity, must wish that the spiritual allianee then created shall endure to the end of time. In our desire to perpetuate the remembrance of those days of duty done together, we, the Consultant Surgeons of the Armies of Britain, ask the College of Surgeons of America, meeting in this great Dominion, to accept this Mace. We pray that you may regard it as a symbol of our union in the harsh days of trial ; as a pledge of our devotion to the same imperishable ideals ; as a witness to our unfaltering and unchanging hope that the members of our profession in the two lands shall be joined in brotherhood for ever in the service of mankind."

Colonel G. E. Armstrong, C.M.G., President of the American College of Surgeons, in receiving the Mace, said :—

" Sir Berkeley Moynihan : As President of the American College of Surgeons, I accept this beautiful Mace presented by you on behalf of the Consulting Surgeons of the British Armies, with thanks and a full appreciation of the eare and thought bestowed upon its design and construction.

" We accept it as a token of the cordial relationship that obtains between the surgeons of the two great nations here represented. It is the symbol of the zeal and enthusiasm in our art that, originating in the Old World, has spread to the New.

" We shall endeavour in this western hemisphere to keep the 'Saered Flame of Scienee' burning not less brightly than have our forebears in Great Britain. It will remain with us as an emblem of unity, a work of art, a remembranee of the united effort of the two great English-speaking nations to give truth, liberty, and justice to all peoples and to all nations.

" The scientific fire represented in this gift welds another link in the chain that shall for ever bind us together in the great work of promoting the highest possible standard of surgery, as well as peace and good-will among men.

THE EDUCATION OF A SURGEON UNDER THOMAS VICARY.

By Sir D'ARCY POWER, K.B.E., London.

(The Second Vicary Historical Lecture, delivered at the Royal College of Surgeons of England on November 11, 1920.)

Mr. President, Master of the Worshipful Company of Barbers, Ladies and Gentlemen :—

It is a function of history to correct the errors into which we are betrayed by mere forgetfulness. Generation succeeds generation until we are apt to think that our fathers were less skilful, or were less alive to their surroundings, than ourselves. I have chosen "The Education of a Surgeon under Thomas Vicary" as the subject of the second historical lecture at this College to combat this thought. We owe the lectureship itself to the good will of the Barbers' Company, once our competitors, then our allies, and now our very good friends. I desire to testify publicly to the satisfaction which this evidence of reconciliation excites in the minds of those who know the good historical work done by the late Mr. John Flint South, formerly President of this College, and by the late Mr. Sidney Young, a Past Master of the Worshipful Company of Barbers, work which is still being carried on by Mr. Past Master Weston and other members of the Court of Assistants.

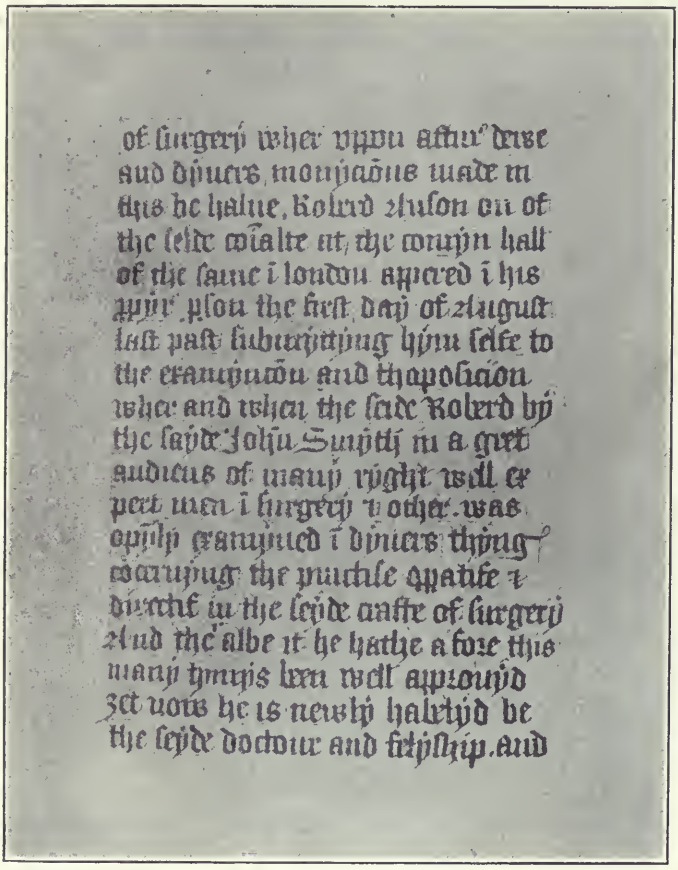
I do not know who decided that the historical lecture should be called The Vicary Lecture, but it was a wise choice, because Vicary, in virtue of his age and position, was foremost amongst that band of pioneer surgeons who, in the reign of Henry VIII, desired to see their calling advanced from a trade to a profession. Their work was not crowned with complete success, but to their labours the surgeon owes in part his present social position in this country.

During the whole of Vicary's life medical education was undergoing changes analogous to those now occurring to which the term reconstruction is applied, and for similar reasons. In many ways the fifteenth century resembled the present time. The Wars of the Roses practically destroyed the old nobility, for attainders and executions altered the ownership of land throughout the country, whilst crushing taxation and the general insecurity hampered trade and materially reduced the wealth of the citizens. It was impossible to do business in London when such thousands of troops were quartered in the neighbourhood or were actually billeted on the citizens that "the Mayor rode daily about the city and the circuit of Holborn and Fleet Street, accompanied by five thousand craftsmen or thereabout, well and sensibly arrayed", to maintain order and prevent looting. From 1450 to 1485 English surgery suffered in the general dislocation of affairs, and no advance was made. The death of Richard on the field of Bosworth, the succession of the Earl of Richmond as King Henry VII, and his marriage with the Lady Elizabeth of York a year later, gave peace to the realm. Then, as now, the surviving generation turned for a time to religion rather than to secular matters. There was a period of church building, church restoration, and the foundation of chantries, in the same spirit which is now leading to the erection of crosses and memorials in churches and villages throughout the country.

Surgeons undoubtedly felt the lean time. London had always supported a small body of surgeons independently of the barbers. These men performed the same duties as ourselves. They undertook the more difficult operations, were called in consultation to obscure cases, and generally considered themselves to be on a higher plane than the barbers. Their practice, however, was somewhat different from our own, for they were

Fig. 162.—Thomas Vicary.

itinerant; that is to say, when they undertook an operation they stayed with the patient until he was cured, and they seem for the most part to have been attached to the persons of the higher nobility. They charged large fees, because they could only undertake a single case at a time, and might be months before they were released from their attendance. When their lord was called out in the course of war they accompanied him, and thus saw much military service. They received their pay rather in kind than in money, for at the time of which we are speaking Ambroise Paré was paid with a cask of wine, a horse, a diamond, and a promise from a patient that he would never let him want. Such promises were quite numerous, and were usually estimated at their proper value.



of ſurgery whet vppon aſſay diſe
and dyuers mony̆acons made in
this be halue, Robert Thuſon on of
the ſeide maiſte at the comyn hall
of the ſame in londou appered in his
ꝑſon the firſt day of auguſt
laſt paſt ſubmyttyng hym ſelfe to
the examynacon and thapobacon
who: and what the ſaide Robert by
the ſayde Johñ Smyth in a gret
audiens of many right well ex
pert men in ſurgery & other was
openly examyned in dyuers thyng
concernyng the practyſe & dyſcrete in the ſeyde craft of ſurgery
And the albe it he hathe a fore this
many tymys ben well approuyd
zet nowe he is newly halowyd be
the ſeyde doctour and felyſhip. and

FIG. 163.

During the hundred years' war with France, and during the Lancastrian and Yorkist wars in England, surgeons no doubt made a good but precarious living. With the reign of Henry VII began a long and settled peace, which obliged the surgeons to reconsider their position. The old and wealthy nobility had been destroyed, and they were compelled to turn their attention to the newly-formed middle class as it was represented by the citizens. For this purpose they entered into an agreement with the Barbers' Company in 1493—the eighth year of the reign of King Henry VII—and in this agreement there is a special clause dealing with the examination of surgeons. The licence of Robert Anson is still in existence, and is dated August 8, 1497. It states (*Fig.* 163) that he was examined by "Master John Smyth Doctour in Phesik, Instructour & examenar of the feliship . . . in a gret audiens of many ryght well expert men in surgery & others". Even at this early period, therefore, a special examiner had been appointed to conduct a public examination in surgery. Examination of surgeons, however, was no new thing in the fraternity of surgeons, for it was proposed in the abortive scheme of 1423, which aimed at uniting surgeons and physicians, as well as in the ordinances of 1435, which regulated the gild for many years. It seems, therefore, that the fraternity of surgeons dealt more with the practising surgeon than with the apprentice. It desired to ascertain what a man knew rather than how he had gained his knowledge—in other words, whether he was a reasonably safe practitioner—before he was allowed to practise in the area over which it ruled.

The Company of Barbers, on the other hand, dealt more with the apprentice, for the London gilds, even before they became chartered companies, had always taken an interest in the education of their members, and had endeavoured by a system of apprenticeship to provide satisfactory craftsmen. Provision for teaching and evidence of professional knowledge both before and after admission to the freedom had always been made by the Company of Barbers in London. Elsewhere in England the custom varied. Education was insisted upon when the gild consisted of barbers united with surgeons, as at Norwich, Bristol, and Edinburgh, and when the barber surgeons and physicians worked together, as at York. There was no such demand when the mystery of surgery and barbery was a mere trade, as at Oxford where it was associated with the waferers and makers of singing-bread, or at Newcastle where it was combined with the wax chandlers; but even in these gilds there is evidence that a minimum of professional knowledge was demanded of applicants for the freedom on the surgical side.

The Company of Barbers was formally united with the fraternity of surgeons by the Act of Parliament which received the royal assent on July 25, 1540. Vicary was elected Master of the United Company at the end of John Pen's term of office, and acted in this capacity from September, 1541, to the usual date of election in September, 1542. The Union is commemorated in the well-known picture by Holbein, which has fortunately preserved for us portraits of the chief actors.

The United Company immediately proceeded to consider the state of the profession, and found that there were two problems to be solved—the one internal, the other external. The internal problem was itself twofold, and concerned the better education of the profession; the external problem was the better education of the public to appreciate the proper treatment of surgical disease. The internal problem had already been partially answered, and by combining the customs of the barbers in regard to their apprentices with the regulations of the surgeons in dealing with those licensed to practise, a fairly adequate system of surgical education was evolved. No complete medical education, however, could be given so long as the surgeon was subordinate to the physician. This subordination remained for many years, and the second part of the internal problem could not therefore be solved.

Apprentices.—Very few lists of apprentices to barbers have been published, but it is clear from a study of such of them as exist that the boys were drawn from the lower classes, as the occupation of the father is frequently given as a 'labourer'. There is no evidence to show that the surgeons' apprentices came from a much higher class. A successful surgeon sometimes took his son as apprentice, as in the case of Thomas Gale and his son William Gale; William Clowes and William Clowes junior. The Arris family, to whom we owe the Arris bequest, lasted through three generations. Jasper Arris was a barber as well as a surgeon; Mr. Alderman Edward Arris, his son, was a surgeon and did no barbery; his eldest son Robert followed the grandfather and father as a surgeon, whilst the second son became a doctor of medicine, a Fellow of the Royal College of Physicians, and a Member of Parliament; but then Mr. Alderman Arris was the father of twenty-three children, so he could well afford to give two to the profession of medicine. As a rule, however, the surgical apprentices were drawn from the humblest ranks, and owed any position to which they attained entirely to their own talents. Thomas Gale says in *An Institution of a Chirurgion*, "Few that have wel brought up their sonne will put him to the arte, bicause it is accounted so beggerly and vile". Similar testimony is borne by Sir Humphrey Gilbert as late as 1570 in that curious tract* which foreshadows the present University of London. Writing to Queen Elizabeth about "The erection of an Achademy in London for educacion of her Maiestes Wardes and others the youth of nobility and gentlemen", he says, "The Phisition shall practize to reade Chirurgerie, becawse thorough wante of learning therein we haue verie few good Chirurgions yf any at all. By reason that Chirurgerie is not now to be learned in any other place than in a Barbors shoppe". Here, too, is the

* Brit. Mus. Lansdowne MS. 98.

story of Mr. Thomas Hollier, who was Master of the Company in 1673. He was surgeon at St. Thomas's Hospital, and cut Mr. Pepys for the stone. Indeed, he was so lucky a lithotomist that he cut no less than thirty persons for the stone in one year without a single death. Mr. Pepys was fortunate in coming under him at this time, for his instruments afterwards became septic, and many of the rest of his patients died. I have only lately discovered this contemporary story of his rise. It is told by the Rev. John Ward, Vicar of Stratford-on-Avon, whose commonplace books I am slowly transcribing. He says : " Mr. Holliard, the great Chirurgion in Warwick Lane, was a poor boy in Coventrie, his father was a cobbler, or at best but a poor shoemaker in Coventrie, and one Dr. Mathias (I think he was Queen Anne's Dr.)* about that time frequently coming to Combe Abbey and using Coventrie much spoke to Abraham Ashby an Apoteearie there to help him to a boy to dresse his horses and ride along with him ; and Mr. Ashby spoke to Mr. White the Schoolmaster who told him he could help him to one, but his father was a foxing, drunken fellow, and the boy that he helped him to was this Mr. Holliard, the Chirurgion ; and afterwards Dr. Mathias died and Mr. Holliard got himself a little money and put himself prentice to Mr. Mullins his father of Shooe Lane and now he comes to what he is." The Mullins, father and son, were surgeons to St. Thomas's Hospital and were also eminent lithotomists.

Apprenticeship.—The first step in the life of an apprentice was the sealing of his indentures and their enrolment at Barber Surgeons' Hall in Monkwell Street and at the Guildhall. For this purpose the boy had to appear before the Court or governing body of the Company to show that he was not deformed or suffering from any chronic disease, for it was a tradition handed down from the earliest days of the gilds that the apprentices should be healthy, and free from blemish or from spot. The opportunity was taken to ascertain that he could at least read and write, and it was hoped that he might have some knowledge of Latin. Latin was taught at this time as a living language in the grammar schools throughout the country, so that a smattering of it might reasonably be expected, and a boy who knew no Latin must have been very badly educated indeed. Accordingly, in 1556, an ordinance was issued that no surgeon should take as an apprentice " but that he can skill of the Latten tongue and understand of the same ", under penalty of a fine of forty shillings. It seems, however, to have been impossible to maintain the rule, for it was rescinded the following year, and in 1563 Thomas Gale, dedicating his *Enchiridion of Surgery* " unto the young men of his Companie, studients in the noble art of Chirurgerie ", says that he wrote in English " because the books you should use are written in a tongue which the most of you understand not ".

At this time the boy was about 14 years old, and if he passed before the Court and his indentures were registered his period of servitude began. It usually lasted for seven years, in which case he would be made free of the Company and could practise on his own account by the time he was twenty-one. The period of apprenticeship, however, might be prolonged for eight or even nine years. The fee paid to the master was at first merely sufficient to cover the expense of clothing and feeding the boy in return for his services. In later years—when apprenticeship carried with it valuable reversions, as in the case of those who were bound to hospital surgeons like Hunter, Abernethy, and Astley Cooper—fees of £500 to £1000, which were then thought to be enormous, were readily paid.

Each master was allowed to take three or four apprentices according to his position in the Company, and if he died the apprentice was 'turned over' to another master or to the widow for the remainder of the term for which he was bound.

The average number of apprentices presented annually at the Barbers' Hall was 150, so that if the indentures lasted seven years there were always about 1000 apprentices belonging to the Barber Surgeons alone, and the other City companies had them in proportion. They were all strong and lusty young men, and a tight hand had to be kept

* Anne of Denmark, married to James the First of England and Sixth of Scotland.

over them. The Barber Surgeons fortunately had ample disciplinary powers over their apprentices, for they could whip or imprison them, or suit the penalty to the crime, as when they ordered a young dandy's head to be shaved when it was fashionable to wear the hair long.

Surgical Education.—As soon as the United Company had obtained the Act of Parliament in 1540, arrangements were made to provide an improved system of surgical education. Some machinery already existed for the purpose, as the Gild of Surgeons had always taught both its members and apprentices by a system of lectures. Each member of the gild was pledged under a fine of twenty shillings, either to lecture himself or provide an efficient substitute. The lectures must have been oral, and, so far as I know, there are no manuscripts or students' copies of them in existence at the present time. Morested, Bradwardyn, Ferris, Keble, and other great surgeons of the fifteenth and sixteenth centuries are thus nothing more than names to us, for they have left no literary remains, though we know from the evidence of their pupils that they exercised a great influence in promoting a higher standard of surgical teaching and ethics. It is probable that their lectures dealt largely with their own experience and with the remedies they found most serviceable.

Anatomy.—Anatomy had always been taught, for it was the basis of surgery, but some far-seeing members of the gild got its teaching regularized by the introduction of the following clause in the Act of 1540: "That the sayd maysters or gouernours of the mistery and comminaltie of barbours and surgeons of London, and their successours yerely for euer after their sa[i]d discrecions at their free liberte and pleasure shal and maie haue and take without contradiction foure persons condempned adiudged and put to deathe for feloni by the due order of the kynges lawe of thys realme for anatomies without any further sute or labour to be made to the kyngs highnes his heyres or successours for the same. And to make incision of the same deade bodies or otherwyse to order the same after their said discrecions at their pleasures for their further and better knowlage instruction insight learnyng and experience in the sayd seyence or facultie of surgery." A supply of bodies was thus insured and the Company at once elaborated a system for putting them to the best use. They appointed a lecturer with the title of Reader of Anatomy, and four stewards or, as they would now be called, demonstrators under him. The Reader of Anatomy seems at first to have held office for an indefinite period, but he was afterwards appointef dor terms of three to five years. The stewards acted for four years; during the first two they learnt their duties, and during the last two they executed them under the direction of the Reader, and were called Masters of Anatomy. Unfortunately there are no extant records of the first few years of the Company's existence, so that it is impossible to discover who was appointed the first Reader of Anatomy. I believe, personally, that it was Master Vicary himself, and that he lectured on the old lines. My predecessors, the surgeons of St. Bartholomew's Hospital, published *The English-mans Treasure. With the true Anatomie of Mans Body*, after his death. There has always been a tradition that it first saw the light in 1543, although it was not printed until 1577. It is a worthless treatise on anatomy based upon the teaching of Lanfranc and Henri de Mondeville, but it shows that Vicary was looked upon as an anatomist by his contemporaries, and the edition of 1543 may have been the text from which he had lectured. Be this as it may, a vacancy for a Reader of Anatomy occurred about 1546, and the Company adopted the wise policy of choosing the best possible man for the post. They elected, no doubt by the advice of Vicary and on the recommendation of Dr. Butts, Dr. John Caius, a Cambridge graduate, aged 36. Caius had lately returned from Italy, where he had been a fellow lodger with Vesalius at Padua and an acquaintance of Realdus Columbus, the two great anatomists of their age. He was also a competent Greek scholar, and had made a special study of Galen, hunting through the great libraries of Italy for accurate texts. In 1544 he issued his edition of the *De Medendi Methodo* and other works of Galen which had not previously been published. No better choice could have been made by a young and virile society which included a large uncultured element amongst its members. Caius was a grave and learned man, a stickler for etiquette, and a bachelor. He lived in the

FIG. 164.—John Banester delivering the visceral lecture at the Barber Surgeons' Hall, London, in 1581.
By permission of the Wellcome Historical Medical Museum

immediate neighbourhood of the Barber Surgeons' Hall in Monkwell Street, for he had a house in St. Bartholomew's Hospital, and could thus devote sufficient time and energy to his work. He held office until 1563, and was succeeded by Dr. Cunningham. His long tenure of the lectureship left a permanent mark upon the teaching. The Reader of the Anatomy was ever afterwards a young university graduate. The post was well paid, and many of its holders subsequently achieved fame. The Anatomy of Realdus Columbus was long a recognized text-book, and some work of Galen, either the *De Methodo* or the *Therapeuticon*, with a slight knowledge of Hippocrates, was required of every apprentice or surgeon before he was granted the licence of the Company.

It is easy to reconstruct the manner in which anatomy was taught in the sixteenth century, for this picture (*Fig.* 164) is a faithful representation of such a lecture as it was given in the anatomical theatre at the Barber Surgeons' Hall. It shows John Banester delivering the visceral lecture in the year 1581. The two Masters of Anatomy with a probe and scalpel stand beside him, whilst the two stewards are on the opposite side of the table. The minute accuracy of detail is shown by the *vade mecum* which is being used as the text of the lecture, and it will be noticed that the skeleton is supported and crowned with the colours of the Barber Surgeons' arms, whilst a wreath of the same colours surmounts the helmet in Banester's arms. The book on the reading desk is Realdus Columbus, and from its size I thought it must be the folio edition printed at Venice in 1559. Reference to this edition, however, shows that the passage at which the book is open occurs on folios 227 and 228. The picture gives the pages 419 and 420. Looking about for another edition, I found the octavo published at Paris in 1572, and turning to Chapter 5 of Book XI, I discovered the latter part of the passage quoted occurring just as the painter saw it on pages 419 and 420. It shows that Banester had not only chosen the last edition of his text-book to lecture from, but for the convenience of the students he had selected the cheaper and more portable book. Time has dealt gently with Banester, for in addition to the picture of his lecture, there exists in the University Library at Cambridge a casket of wood and leather ornamented with gold and blind tooling, containing the anatomical figure of a man and an ivory skeleton. The inscription on the box (*Fig.* 165) reads

> "Iohannes Banister Medicus
> Londinensis, & Anatomicus insignis, Academiæ
> Cantabrigiensi dono dedit cistellulam hanc, unà-
> cum artificioso Scelcto, & exteriorum musculo-
> rum humani corporis Icone, affabrè factis, & in
> eadem contentis. Anno Dom. 1591."

The casket is too fragile to travel, but Dr. Jenkinson, the University Librarian, has kindly allowed me to have it and its contents photographed (*Figs.* 165 and 166).

The subjects were probably chosen with considerable care during their life, as the executions were so numerous that a selection could be made. The material was of the best, as very little physical damage was done at the hanging. The medical students in Vicary's time, therefore, were in a much better position than their successors two hundred years later, who had to resurrect the body, and, in consequence, rarely had an opportunity of seeing the muscles and tissues of the neck, which were always lacerated in the process of exhumation, or by the violence of the long drop. Indeed, so slight was the injury inflicted at Tyburn, and the subjects so often recovered when they were brought to the Hall, that the following order was made on July 13, 1587: "Item yt ys agreed That yf any bodie w^{ch} shall at anie tyme hereafter happen to be brought to o^{r} Hall for the intent to be wrought uppon by Thanatomistes of o^{r} Companie shall revyve or come to lyfe agayne as of late hathe ben seene The charges aboute the same bodie so reviving shall be borne levied and susteyned by such person or persons who shall so happen to bringe home the Bodie. And further shall abide suche order or ffyne as this Howse shall Awarde." After this the subjects do not appear to have come to life again. There was no difficulty at first in obtaining the bodies, but in later years the Company had sometimes

to be assisted by a military guard, so fierce was the resistance offered by the mob at the place of execution.

Bodies being relatively plentiful, they were dissected by systems rather than by regions, a plan which is still customary in the veterinary schools of this country. The viscera were considered first, as being the most perishable, the muscles and arteries next, the bones, ligaments, and joints last. Different benefactors endowed different

FIG. 165.

lectureships for this purpose, and thus arose a visceral lecture, a muscular lecture, and an osteological lecture. Of these lectureships vestigia still remain in our Arris and Gale lectureship ; the Arris bequest being originally devoted to a muscular and the Gale to an osteological lectureship.

The anatomical teaching was long kept in the hands of the Barbers' and Surgeons' Company as a strict monopoly, and no body could be dissected by any of its members without leave from the Company. Such leave, however, was not unduly withheld when

application was made in a proper manner. Thus there arose two classes of anatomy. The one, called the public anatomy, was the formal dissection of the bodies of the four criminals. It soon became one of the sights of London, and involved the United Company in some expense to provide proper accommodation for the crowds who attended. The second class consisted of private anatomies held as opportunity occurred, or as occasion required, by those who were devoting themselves to anatomy as a study.

FIG. 166.

Each of the public anatomies lasted for three days, after which for another three days the masters of the anatomy were allowed to teach their pupils, the whole business being ended with a feast, and it was the duty of the two junior stewards of anatomy to see that the tables were properly furnished. The more distinguished visitors attending the dissection were invited to the banquet, and for this hospitality on the part of the Company we are indebted for the account left us by Mr. Pepys, on Feb. 27, 1662–3, of Dr. Scarborough's demonstration of the parts concerned in vesical calculus. For each

of the public anatomies the lecturer received £10 and the masters of anatomy £3 each, the total expense being £22 14s. 6d.

Surgery.—Surgery was taught by a compulsory lecture given every Tuesday afternoon throughout the year; Tuesday being chosen because it was the day on which the Court of Assistants, or, as we should say, the Council, held its ordinary meeting. The earlier apprentices and surgeons of the United Company were fortunate in their teachers. Caius was the lecturer on anatomy; Gale (*Fig.* 163), Clowes, Halle (*Fig.* 169), and Balthrop taught surgery. Rough men, of uncertain temper and with much mother wit, they had been trained in the wars, were attached to large hospitals, and had the chief surgical practice in London. They quarrelled violently, fought each other with their fists, and sometimes promised to cure patients who were incurable, for which they were duly reprimanded by the Company and made to refund the fee. But in their writings at any rate they speak kindly of each other, and wrote verses to recommend each other's books. They were in truth a band united, as I shall show presently, with the common object of raising the status of surgery.

The lectures were arranged in courses, each course being given in turn, the 'auncientist Surgeon' beginning, and the others in due order following. As in the case of anatomy, the lectures took the form of a running commentary upon a text-book, the text-book being either one in traditional use, like Guydo's *Questions*, which had been translated into English, or the *Surgery* of Tagaultius, which was in Latin, or it might be one written by the lecturer himself. Gui and Tagaultius were respectively the 'Rose and Carless' and the 'Gask and Wilson' of the day. I have read both. They really contain a great deal of sound and useful surgery if they are considered in the light of contemporary knowledge. A part of the course was devoted to bandages, the recognition of surgical instruments, and the use of such drugs and external applications as were allowed the surgeons by the physicians.

Lapse of years removed this brilliant band of surgeons, and no worthy successors were forthcoming. The Company made repeated appeals to the surgical members, and tried to make them lecture, or in default pay a fine. They preferred to pay the fine, until, at last, in desperation, a paid lecturer on surgery was appointed, and the surgeons were ordered to find his salary of £20 a year out of their own pockets. I show you here the surgical text-books of the time. In addition to Gui and Tagaultius, which I have just mentioned, they are Oribasius; Halle's edition of Lanfrane; Gale's *Surgery* and translations of Galen; several works of Clowes; Banester's *Treatise on Ulcers*; Bullen's *Dialogues*; Valerius Cordus for drugs; and Realdus Columbus for anatomy.

Pathology.—Pathology was sometimes allotted to the lecturer on anatomy and was sometimes a part of the surgical course. Inflammation and its results, and the various kinds of tumours, were common to each course. In the hands of the anatomist—because he was a physician—various treatises of Galen and a little Hippocrates were also dwelt upon; the surgeons, less learned and knowing no Greek, either had the Latin versions translated into English, or, as is more likely, curtailed this portion of the course to the great advantage of their audience, for the matter was both dry and useless. It is somewhat remarkable that no attempt was made to teach by clinical examination; indeed, there is some evidence to show that the introduction of patients at lectures was definitely forbidden. It was not until 1602 that a clinical examination was first required, and then it was in Scotland.

Examination.—The United Company elaborated their system of examination with considerable care. No one could practise surgery in the city of London or within a radius of seven miles without their licence, and it was decided that examination was the best means of determining a man's fitness to practise. Two classes of candidates presented themselves: (i) their own apprentices, and (ii) surgeons who had been in practice elsewhere —foreigners as they were called technically—and who wished to settle in London. The first step of the United Company, therefore, was to appoint eight examiners, the number being afterwards increased to ten—freemen of the Company, of course, but not necessarily of the Assistance or Council. Four of these examiners undertook the examination of candidates in the presence of the Master and Wardens of the Company, who might, of

course, be barbers, knowing nothing of surgery. Upon the report of the examiners the Master, Wardens, and Court of Assistants granted the licence, or preferment of grace as it was called.

We have a clear picture of the method of procedure. As soon as the apprentice was out of his indentures he presented himself at the Hall in Monkwell Street with a recommendation from his Master. Ushered into the Hall (*Fig.* 167), he was asked by the Master and Wardens what he intended to do after he was made free of the Company. If he replied that he proposed to practise surgery, he was asked whether he meant to settle in London. If he said, "That is my intention," he was sent over to the examiners, of whom four were always present, and they proceeded to test his knowledge. They asked him in English about anatomy and surgery; of what parts they consisted; what were the bones, their number in different parts of the body, how they were moved; where the large vessels ran; what was the use of the liver, the spleen, and brain; in surgery and pathology what were the tumours *præter naturam*, how he would treat an apostume or inflammation, what should be done for the bite of a mad dog, what were the causes of blood

FIG. 167.

in the water, what was a struma, and so on. If his answers proved satisfactory—and they did not always prove so—he was licensed to practise surgery for a term of years varying with the knowledge he had shown, and was admitted a freeman of the Company.

In the early days, of which alone I am now speaking, he was advised at the same time to proceed to the higher degree of Master of Anatomy and Surgery—the second preferment of grace—and was told that he could do so either by writing an Epistle, i.e., a thesis to be read before the Company every six months; or, if he were not gifted with the pen of a ready writer, he might be examined half-yearly to determine what improvement he had made in practice. If the candidate were then approved, he was formally admitted a Master of Surgery and Anatomy, which was a permanent licence to practise, and allowed him to apply to the Bishop of London for the Bishop's licence, which "is said to be confirmation of a Surgeon". Few, however, took the second step, and it seems to have quickly fallen into disuse, its place being taken by 'the Great Diploma', granted after a special examination to those who aspired to the highest surgical position. It was somewhat analogous to our Fellowship examination.

The cost of the licence was viiid.; the cost of the Mastership was a spoon weighing an ounce of silver, with the applicant's name written upon it, as a present to the Company, and viiid. to the clerk for enrolling the name.

Rejections were not infrequent, but it was more usual to grant an ignorant man a temporary licence, either for a short time or on condition that he should call in some more experienced member of the Company whenever he had to treat a patient. Occasionally the candidate was so shockingly bad that the coroner was invited to hear the examination —a good practical way of saving subsequent inquests. Here is an example: "One John ffoster a poore and unskylfull man of this Company made his appearance before the Mrs. of this Company and was examined concerninge his skyll in the arte of Surgery and was found altogether unskilfull in all the partes thereof. Whereuppon it is ordered that Mr. Wilbraham, Coroner to this Cytie, be warned to be here with the Coroner's Inquest on Thursdaye next by tenne of the clock in the forenoone to be satisfied by their owne hereinge of the unskilfullness of the said ffoster."

When the apprentice said that he did not intend to practise in London or the suburbs, he was admitted to the freedom of the Company without examination, and went his way to get the licence required in the district where he settled, whilst he had the added dignity of having been educated in London.

It was also possible for a surgeon to obtain a licence to practise even though he had not served an apprenticeship to a freeman of the Company. Such licences were often granted to pleasure some great man and upon his personal application. It was productive of much harm, and detracted from the reputation of the Company when the Master and Wardens were mercenary, or when the Company was in financial straits, as frequently happened, for unworthy men were then admitted. John Read, of Gloucester, took the Company to task for this fault. He says many do "practise abroad their accustomed deceipts under the colour of admittance from the Hall of London. . . . A thing greatly to be lamented that those which are or should be the fathers of arte and upholders of good artists should so slightly passe their licence to such ignoraunt asses, to maintaine them, not onely in coosening her Majesties subjects of their monie, but oftentimes depriue them of their lims, yea and also their lives. But it is no meruaile for monie is sweete, and what is it but Luere may doe? for I myselfe, talking with one of the same companie and felowship, complayning uppon the abuses thereof, in passing their licences to such, made me this answere. In deed, quoth he, it is not well, but we were as good to take their monie for they would play the knaves nevertheles . . . I know someone of small learning and lesse knowledge, who hauing trauelled 180 miles to feteh a seale weying fower pound besides the apurtenances therunto belonging, whereby he is growen so farre in love with himself and so undiscretlie doteth ouer his owne doings at his returne that he maketh his travel, and conquest as he thinketh, ordinary table talke, for he walked from Tauerne to Tauerne and from Alehouse to Alehouse with his licence at his girdle closed in a boxe, as though he had been the proctor of some spitell house agrauating the latter so monstrouslie, as if he had endured the verie labours of olde Hercules, and no meruaile, for when he had made his market, and receaued his letters of marke, falling in companie with some others, and grewe in speeches of practise (for there uppon he standeth, but his method is small) did not stick to confirm that Arsenick and rusty Bacon, was a present remedie for wounds made with goon-shot. And being another time demaunded by a learned Doctor in Phisicke how a wound came to be an ulcer was strieken dum. And yet of like he might aunswere his examinations well. For that (as he saith) he was used so familiarly and plast amongest the best. A meane surely to embolden him well for he was but bashfull when he was before the worshipfull Doctor. And yet will not stick to make himselfe comparable to any and will impudentlie cracke, that any man shal neuer attaine to do the like cures as he hath don, with a great deal more of shamles comparisons."

The possession of a licence did not relieve its holder from what would now be called post-graduate teaching. Under penalty of a fine the members of the Company, including the Master and Wardens, were obliged to attend the demonstrations in anatomy and the lectures on surgery, exemptions being only rarely granted. They had not only

to attend, but for the honour of the Company they had to come properly dressed, they were bound to remain the whole time, and were enjoined not to ask questions until the lecture was ended, when they might courteously point out anything which they thought had been taught incorrectly.

Presentation of Cases in Peril of Death or Maim.—From time immemorial there was a most salutary custom of consultation in all serious surgical cases. This was known as "the presentation of patients in peril of death or maim". It applied equally to the oldest practising surgeon and to the one most recently licensed. It provided that everyone who was called in to treat a patient likely to die, or who might afterwards be permanently incapacitated, should summon to his assistance the Master and Wardens, originally of the Gild of Surgeons, later of the United Company, after which the surgeon in attendance was held blameless for anything that might happen. The consultation was held before the third dressing of the patient, practically before the third day. It was jealously enforced, for there are numerous instances of surgeons being fined, sent to prison, and even struck off the roll, for not presenting their cures 'in peril of death or maim'. In the United Company, where the Master or Wardens might be barbers not practising surgery, a surgeon or surgeons could be nominated to act in their place. The work on their part was gratuitous, but provision was made that in case any recompense was offered it should be equally divided amongst them. The system worked satisfactorily, for it applied impartially, gave confidence to the friends of the patient that everything possible had been done, relieved the surgeon of responsibility in a very litigious age, and gave the senior members of the Company a large experience in difficult cases. Incidentally it shows how small must have been the population of London and seven miles round when the Master and Wardens, who were themselves in practice, could undertake such additional labour under the penalty of a fine for not attending when called upon to do so.

Education of the Public to Appreciate Surgery.—The education of the public to appreciate the value of better surgical treatment proved to be a more difficult task than the education of the surgeon himself. Surgery had reached a very low ebb at the beginning of the sixteenth century, for in 1511 an Act of Parliament for the appointing of physicians and surgeons recites that "the science and cunning of Physic and Surgery is daily within this Realm exercised by a great multitude of ignorant persons of whom the greater part have no insight in the same nor in any other kind of learning. Some also can no letters from the Book, so far forth that common Artificers as Smiths, Weavers and Women boldly and accustomably take upon them great Cures . . . to the great infamy of the Faculty and the greivous Hurt, damage and destruction of the King's Liege people most especially of them that cannot discern the uncunning from the cunning". This is confirmed by Clowes some years later, who says "that many in these days do take upon them to intermeddle and practise in this art, wherein they were never trained nor had any experience; of the which a gret number be shameless in countenance, lewd in disposition and brutish in judgement, which do forsake their honest trade whereunto God hath called them and do daily rush into physic and surgery. And some of them be Painters, some Glaziers, some Tailors, some Weavers, some Joiners, some Cutlers, some Cooks, some Bakers and some Chandlers. Yea, now-a-days it is apparent to see how Tinkers, Tooth-drawers, Pedlars, Ostlers, Carters, Porters, Horse-gelders and Horse-leeches, Idiots, Apple-squires, Broom-men, Bawds, Witches, Conjurors, Sooth-sayers, and Sow-gelders, Rogues, Rat-catchers, Runagates and Proctors of Spittle houses with such other like rotten and stinking weeds which do in Town and country, without order, honesty or skill, daily abuse both physic and surgery, having no more perseverance, reason or knowledge in this art than hath a goose, and most commonly useth one remedy for all diseases and one way of curing to all persons both old and young, men, women and children which is as possible to be performed or to be true as for a shoe-maker with one last to make a shoe to fit for every man's foot and this is one principal cause that so many perish". The state of surgery indeed was nearly such as to warrant the advice given to a surgeon by William of Saliect in 1275, that "a wise surgeon will do well to refrain from stealing anything while he is actually in attendance and will not employ notoriously bad

characters as his assistants because such actions are apt to lessen the confidence of the patient and may thus spoil an otherwise good operation".

It is clear that the whole country was overrun by quacks, for we have accounts of their doings in London, Maidstone, and Gloucester, which are now merely amusing, but were then of serious importance. Take a single example from each town. Gale (*Fig.* 168) says: "In the year 1562 I did see in the 2 Hospitals of London, called St. Thomas's Hospital and St. Bartholomew's Hospital, to the number of 300 and odd poor people that were diseased of sore legs, sore arms, feet and hands with other

Thomas Gale,

FIG. 168.

parts of the body so sore infected that one hundred and twenty of them could never be recovered without loss of a leg or an arm, a foot or a hand, fingers or toes, or else their limbs crooked so that they were either maimed or else undone for ever. All these were brought to this mischief by witches, by women, by counterfeit javils that took upon them to use the art of surgery, not only robbing them of their money but of their limbs and perpetual health. And I, and certain others, diligently examining these poor people how they came by their greivous hurts and who were their chirurgions that looked unto them, and they confessed that they were either witches which did promise by charms to make them whole, or else some women which would make them whole with herbs and

such like things, or else some vagabound javil which runneth from one country to another promising unto them health only to deceive them of their money. But what manner of cures they did I have told you, such cures as maketh the devil in hell to dance for joy to see the poor members of Jesus Christ so miserably tormented ".

This state of affairs in London is borne out by Clowes, who mentions that he had amputated seven arms and legs in a morning at St. Bartholomew's Hospital. This statement was not made boastingly, but incidentally as showing a part of his routine work.

FIG. 169.—John Halle.

It was no better in Kent, for Master John Halle (*Fig.* 169) of Maidstone reports that in 1562 there came " one William, a shoe-maker, pretending to be very cunning in curing of diseases of the eyes ; and being brought to a friend of myne to have his judgement in one eye, whereof the sight was weake ; first putting them in much fear of the eye he at length promised to doe great thinges therto. But the friends of the party diseased desired me first to talke with him to understande his cunning ; which, at their request, I did at a time appointed and asked him if he understoode what was the cause of her infirmitie. He said he could not tel but he wold heale her he doubted not. Then I asked him whether he were a surgion or a physitien ; he ansered no he was a shoe-maker

but he could heale all manner of sore eyes. I asked him where he learned that; he sayde that was no matter. Well, sayde I, seyng that you can heale sore eyes what is an eye? Whereof is it made? Of what members or parts is it composed? And he sayde he knewe not that.

"Then I asked hym if he were worthy to be a shoe-maker or to be so called that knewe not howe or wherof a shoe was made? He answered, no, he was not worthy. Then, sayde I, how dare you worke on such a precious and intricate member of man as is the eye, seyng you knowe not the nature therof? and why or by what reason it doth see more than a man's nose or his hande? He answered that though he could not tell this yet could he heale all maner of sore eyes. And that whereas maister Luke of London hath a great name of curyng eyes he coulde do that which maister Luke coulde not doe nor turne his hande to. Thus bragged this proud varlette against and above that reverent man of knowne learning and experience.

"And I sayde, I thought so, for Maister Luke, sayde I, is no shoe-maker. Well, sayde he, I perceive you do but skorne me and flunge out of the doores in a great fume and could not be caused to tary and drynke by any intreaty neither have I since that tyme heard anythyng of hym".

The same story comes from Gloucester, where, as it was near a seaport, there were foreign, as well as indigenous, rogues to contend with. For example: Read tells us that "there came a flemming into the cittie of Gloeeter named Woolfgange Frolieke, and there hanging forth his picture, his flagges, his instruments and his letters of marte with long labels, great tossels, broad seales closed in boxes, with such counterfeit showes and knackes of knaverie cosening the people of their monie without either learning or knowledge, and yet for money got him a license to practise at Bristowe (Bristol). But when he came to Glocester & being called before some being in auethoritie by my selfe & others, he was not able to aunser to any one poynt in Chirurgerie, which being perceived and the man knowen the matter was excused by way of Charitie to be good to straungers".

This attitude of toleranee towards quaeks was the root of the evil, and it was so general that in 1542 (34–35 H. 8. Ch. 8) a Bill was promoted in Parliament "that persons being no common surgeons may minister Medieines notwithstanding the Statute". The Bill passed, and it "ordained, established and enacted that at all time from heneeforth it shall be lawful to every person being the King's subjeet, having knowledge and experienee of the nature of herbs, roots and waters by speculation or praetise to use and minister them to their eunning". This opened the door very widely to unlicensed praetitioners, for the position of the surgeons was not safeguarded in any way, not even as Guthrie suggested many years later (April 29, 1834), that a quaek should be allowed to practise if he took out an annual licence, and should be punishable for ignorance as well as negligence, whilst a duly qualified praetitioner should not be required to renew his licenee annually and should only be punishable for negligence.

Lack of Medical Education.—Surgery in England had always been subservient to physie, and in this subordinate position it was destined to remain until our own times. The physicians, oppressed by the weight of tradition, were bound by the fetters of the various seets whieh arose suceessively in medieine. They only made very slow advanees in praetiee, and their progress was actually retarded by the interposition of the apothecaries between themselves and their patients.

The surgeons, on the other hand, were neeessarily brought faee to faee with the same problems whieh eonfront us to-day. When should wounds be closed? When must they be left open? Was it safe to leave a head injury untreated, or should it be operated upon? What was best to be done for the injuries which daily presented themselves as a result of trade aeeidents, or the disputes which were of constant oeeurrence in mediæval towns where everyone went armed and passions were easily inflamed. Readiness of resource, mother-wit, and a fair average of manipulative skill were characteristies of the Tudor surgeon, and he trepanned the head, opened the chest, cut for stone, and amputated with remarkable sueeess. He also had some knowledge of herbs and simples, and

there had been handed down to him an antidotary or collection of prescriptions which had proved useful to his predecessors. But of medicine he had no knowledge. All that he did was empirical, and he was in complete ignorance of what would now be called the Institutes of Medicine even as they were then understood.

The result is interesting. There arose for a generation or two excellent surgeons who wrote well in their native tongue and were able to record their experiences. Their books are still worth reading, but they are one and all records of individual cases. No attempt is made to generalize from the results obtained even when the writer could collect from his own observation several similar cases or even whole groups of cases. I suppose we have all passed through this stage when as young men we were proud to publish a single case in one of the medical journals; but as we gained greater experience we cared less for individual facts and thought more of the conclusions we were able to deduce from the correlation of them.

The Tudor surgeons were arrested at the earlier stage, and it was not until a century later that Wiseman began to generalize on his own experience. The absence of this faculty of generalization was, I think, felt instinctively by the great Elizabethan surgeons. They knew that something was wanting in their education, and they believed that if their pupils could be taught medicine as they had learnt surgery, they would be the better for it. Gale says: "Young men should take counsel as well of the learned physician as of the learned surgeon, for this art is so joined together that neither may the parts be divided neither yet the instruments without the overthrow and destruction of the whole art". And in the same way Read says: "I do withall affirm that all chirurgeons ought to be seen in physic, and chirurgery is divided from physic not without great hurt unto mankind". I have no doubt that if the physicians had allowed the surgeons to be taught some medicine they would have been the better for it, and their social position would have been improved, but it is very doubtful whether surgery as a whole would have derived any benefit. Medicine itself was nebulous so long as it was based on speculation rather than on observation, and its teaching at this time would probably have reduced surgery from practice to theory. Gale, like Halle and Banester, puts the position quite temperately when he says, "To counsel with a physician being a grave and learned man in the principles of this art—in matters of weight—I take it to be very necessary; for what is he that is wise that will refuse the counsel of a wise and learned man, and especially of him that possesseth the principles of the same art? For physiologia, whereof the physician taketh his name, is the first and chiefest part which he that worketh in the art of medicine doth prove for that it doth consist in the knowledge of the several natural things, and in the residue thereto appertaining. But yet this doth not follow that a learned and expert chirurgeon should not use diet and purgations and other inward medicines at all times when need doth require".

John Banester writes in the same strain but somewhat more rhetorically: "Some of late more precise than wise have fondly affirmed, foolishly feigned and frantically faced, that the chirurgeon hath not to deal in physic. Small courtesy is it to break faithful friendship or at-one-ment, but it is mad dotage to part that which cannot be separated. How can physic be praised and surgery discommended? Can any man despise surgery and not defame physic? No, sure, he that speaketh evil of the one slandereth both, and he that robbeth the one spoileth the other. For though they be at this time made two distinct arts and the artists severally named, yet sure the one cannot work without some aid from the other, nor the other practise without the aid of both". So, again, John Read—a much younger man and John Banester's son-in-law—claimed that "Chirurgery is maimed and utterly unperfect without the help of those other parts—which consisteth of prescribing inward medicines and convenient diet, and is so near linked with these in alliance that no man deserves to be called a chirurgeon that is ignorant in physic . . . and I do withal affirm that chirurgeons ought to be seen (i.e. examined) in physic, and that the Barber's craft ought not to be termed chirurgery".

Nothing, however, came of this well-intentioned advice. The surgeons remained on

a lower plane, and when the reformers died—first Read, then Gale, followed in due course by Clowes and Banester—no successors, with the exception of Woodall, carried on their work in England under James and Charles.

Thus ends the second Vicary historical lecture. I have tried to show how much the education of a surgeon owes to the wise counsel of a few great men in those critical times, when the fraternity of surgeons could no longer continue along the traditional lines and there was a real danger of surgery passing into the hands of a trade gild. The example set in London was quickly followed in the provinces, and, within a few years of the establishment of the United Company of Barbers and Surgeons, the large towns of England had remodelled their Barbers' Gilds, and had often followed the example of the United Company in the most minute detail. In due course surgery outgrew the need for a union with the barbers, and in 1745 a dissolution of the partnership took place. The disastrous history of the Surgeons' Company showed how useful the alliance with the Barbers had been to the surgeons. The barbers were business men, the surgeons were thoroughly unbusinesslike. The Clerk of the Surgeons' Company defaulted and left the Company penniless ; their building became ruinous ; their library contained no books ; and, finally, by sheer ignorance of their own Constitution, the Company destroyed itself after an inglorious career of forty years. By its supineness and by its tactless methods a host of enemies had been raised up—and it became impossible to establish the bankrupt Company on the old lines. The present College rose, indeed, upon its ruins ; but, because we are now flourishing, do not let us forget how much we owe to the Company of Barbers, our business partners for more than two hundred years, and we shall then understand that the Union of Barbers and Surgeons was not so incongruous or so useless as it at first sight appears.

CLINICAL TYPES OF BAGHDAD BOIL (CUTANEOUS LEISHMANIASIS).

By ZACHARY COPE, London.

Baghdad boil is one of the many popular terms which have been applied to the lesion which results from infection of the cutaneous tissues with those minute organisms, the Leishman-Donovan bodies. Other regional names given to it are Aleppo button, Basra date-mark, and (in India) Frontier sore, whilst the more general terms Oriental sore and

Fig. 170.—Case of cutaneous Leishmaniasis of lupoid type affecting upper lip. The white area is covered by dry epithelial scales. Cured by a few intravenous injections of 1 per cent tartar emetic. Patient caught the disease in Persia.

Tropical sore are also in use. The disease is common in Asia Minor, Syria, Mesopotamia, India, Persia, and East Africa, but in view of its long duration many travellers from those regions to this country are still subject to the disease when they arrive here. Since the affection may simulate closely some common conditions, and inasmuch as I have already

seen serious mistakes in diagnosis and treatment, a note as to the clinical varieties may prove useful.

Infection usually occurs in the most exposed parts—face (*Fig.* 170), hands, or forearms—and is almost certainly transmitted by the bite of a sandfly or mosquito. Multiple lesions are common. Experimentally, it has been shown by Wenyon that the duration from the time of inoculation of infective material to the appearance of the lesion may be as long as six months, though usually the period is, no doubt, much shorter. Sometimes what appears to be an ordinary insect bite does not subside in the usual manner, but passes gradually into a more extensive lesion from which the Leishman bodies can be obtained. I have known a man bitten during one night in more than a dozen places and at the site of each bite there developed a Baghdad boil.

No age is immune, but one attack seems to immunize. In Baghdad most of the children suffer from the affection during the first ten years of life. Adults who enter a region where the condition is endemic frequently develop a lesion. In a unit of about 140 adults to which I was attached, at least 26 developed a Baghdad boil within the year and a half we were stationed there.

If left to itself the disease runs a benign course, resulting in healing in anything from six months to a year. A scar is usually left, which may be very ugly if on the face. Readers of *Hajji Baba* will remember how he "was attacked by a disorder from which few residents, as well as strangers, at Baghdad are exempt, which, terminating by a large pimple, as it dries up, leaves an indelible mark on the skin. To my great mortification it broke out upon the middle of my right cheek, immediately upon the confines of the beard, and there left its baleful print". The cheeks of great numbers of the residents in Baghdad bear testimony to a previous inoculation with the Leishman-Donovan body.

CLINICAL TYPES.

According to the stage of the disease, the amount of tissue reaction, and the occurrence of ulceration and secondary infection, various appearances are presented. The same lesion may simulate various conditions at different stages of its course. The following clinical types can be recognized: the papule, the rounded ulcer, psoriaform, lupoid, syphiloid, epithelioma-like.

FIG. 171.—Baghdad boils on legs. Common rounded ulcer type.

The Papule.—Commonly the lesion starts as a painless papule, rounded and smooth-topped, and perhaps a little scaly. This may persist for several months, and if it occurs in a person past middle age may very closely simulate a rodent ulcer or papilloma. In course of time it will either retrogress or pass into one of the other types.

Rounded Ulcer.—This is the lesion usually figured and described as the typical Oriental sore (*Fig.* 171). The ulcer is circular, and may be anything up to two inches across; it has a definite raised edge on which the epithelium is intact. The ulcerated surface is generally irregular and covered with flabby granulations on which patches of yellow exudation can be seen. The exudation may dry and form crusts. In the healing stage the granulations become redder, healthy-looking, and cleaner, and gradually become covered with epithelium.

Psoriaform.—The elbow is quite a common place for cutaneous Leishmaniasis, and here as well as in other parts the lesion may take the form of a small red area covered with scales. Such a lesion may at first easily simulate and be mistaken for a patch of psoriasis, though the further course will serve to differentiate.

Lupoid and Syphiloid.—Not infrequently the cutaneous infection may take the form of an area of infiltration with ulcerated patches covered by scabs. Such a condition

bears a superficial resemblance to lupus and tertiary syphilis. The development of the lesion is more slow than that due to syphilis, and more quick than that of lupus. There are no 'apple-jelly nodules' seen on pressing with a glass slide, as in the case of lupus.*

The resemblance to a tertiary syphilitic lesion is often close. I have seen cutaneous Leishmaniasis mistaken for tertiary syphilis by very competent observers, and I have made the reverse mistake myself on clinical grounds in a case where pathological investigation and the result of treatment proved the case to be syphilitic.

Epithelioma-like.—It is rarely that an epithelioma is simulated by a Baghdad boil or by any Leishman-Donovan infection. In some cases, however, epithelioma or rodent ulcer may be imitated by the flat indurated papule or by the ulcer with thick raised edges. This resemblance is all the more significant and misleading in view of Macadam's recent note in this JOURNAL on the histological resemblances of Oriental sore to epithelioma.

DIAGNOSIS.

In diagnosing any granuloma or chronic cutaneous lesion in a patient who has recently (i.e., within six to twelve months) been in countries where cutaneous Leishmaniasis is endemic, the possibility of that lesion must be entertained. During the past year I have had several such cases, one of which had been treated ineffectually for eighteen months, and which healed within a month under correct treatment (*Fig.* 172).

FIG. 172.—Case of cutaneous Leishmaniasis affecting region of right thigh, groin, and lower abdomen. Treated in England for eighteen months by attempted excision, etc. Taken by several competent observers (of non-tropical experience) to be syphilis. Cured by a month's course of intravenous injections of tartar emetic.

Diagnosis is usually fairly easy by a microscopic examination of a small portion of tissue from the infiltrated edge of the lesion. It is well not to rest satisfied with one negative examination if the condition at all resembles Leishmaniasis. A positive Wassermann reaction does not prove that the lesion is syphilitic, for syphilis may but aggravate the condition.

TREATMENT.

There are many methods of treating cutaneous Leishmaniasis, but only one specific cure. Various ointments have been recommended (methylene blue, calomel, etc.); the surgical method of excision and the less satisfactory method of scraping have been advocated; and application of solid potassium permanganate or of carbon-dioxide snow, to burn or freeze the sore away, has found favour with some. The exposure to x rays certainly cures in many cases. A few exposures for about three minutes to rays from a rather soft tube has often cured.

But in large ulcers, or in cases where other methods are slow or ineffectual, and especially in ulcers or disfiguring lesions on the face, the best method is to use the specific cure, i.e., tartar emetic. The drug is best administered as a 1 per cent solution intravenously. Starting with 5 c.c. of the sterilized solution, one continues with doses of 7·5 c.c. at intervals of four to seven days, till the sore changes its character and becomes an obviously healing ulcer with no infiltration of the edges. One or two doses may cure, but in the case mentioned above, which had been treated unsuccessfully by excision and other measures, it took eight doses to cure.

* The resemblance to lupus was noted by LEWIS and CUNNINGHAM in 1872.

AN EXPERIMENTAL INVESTIGATION OF THE RESULTS OF LINEAR DIVISION OF THE PYLORIC SPHINCTER.

By CHARLES A. PANNETT, London.

A simple division of the pyloric sphincter muscle (Rammstedt's operation) is now the established method of treatment in congenital hypertrophic stenosis of the pylorus of infants. It is an operation which can be performed in a short time, is followed by but little shock, and the results are better than those after the much more formidable gastro-jejunostomy. Moreover, these results are permanent. The belief that a division of the muscular wall of any part of the gastro-intestinal tract which leaves a gaping wound filled only by the protruding mucosa could be a practical and well-advised measure to take, was at first difficult to adopt, so hazardous and contrary to the accepted methods of intestinal surgery did it seem. But after my first personal experience of its success in a case of congenital hypertrophic stenosis, the question of the applicability of the operation to other diseases of the stomach immediately obtruded itself, and the present inquiry was instituted to determine the immediate and remote effects upon the normal stomach of a division of the pyloric sphincter without injury to the mucosa, in cats.

Method Employed.—After preliminary trials, three operations were performed, one on a male and two on female cats. After an all-night fast to ensure that the stomach should be empty, the animals were given a meal of boiled pounded fish mixed with barium sulphate to make it opaque. Skiagrams of the passage of this meal from the stomach were taken before and after operation. The animals required some training before successful photographs could be taken with the only apparatus then at my disposal, an instrument with which a 4 to 5 seconds' exposure was necessary. They were inclined to start when the noise of the sparking coil or tube was heard. But it was found possible to teach the two female cats to remain quiet and undisturbed. The negatives from the male cat were all unsatisfactory: it was a far less tractable animal. At the operation an incision about half an inch long was made on the anterior aspect of the pyloric sphincter, encroaching, of course, on to the stomach and duodenum at each end. The omentum was then pulled up and sutured to the neighbouring muscle to protect the exposed mucosa. The abdomen was closed, sutures of plain catgut being used for the abdominal wall and skin. All the wounds healed by first intention, and the sutures were allowed to become absorbed spontaneously.

The Anatomical Effects.—The animals were killed 7, 14, and 18 weeks after operation. Post mortem, in all three there were no adhesions except that of the omentum to the site of operation, and these were separable easily. The cat killed 7 weeks after operation showed a simple linear scar, and histological examination revealed the fact that an extremely thin stratum of muscle next to the mucosa had not been severed, though the wound gaped widely at operation. The cat killed 14 weeks after operation showed a shallow diverticulum at the site of the division of the sphincter, with no covering layer of muscle; and that killed 18 weeks after operation showed a moderately wide scar with no hernial bulge of the wall of the sphincteric canal in this situation.

The Effect upon Function.—*Figs.* 173 to 178 were drawn with a reducing apparatus from skiagrams, and a comparison of the two series shows the effect of the operation upon the emptying time of the stomach. The interpretation to be put upon such series can be arrived at only after a very careful consideration of all the factors in the experiment. It is very difficult to reproduce, in all their details, the circumstances in being at

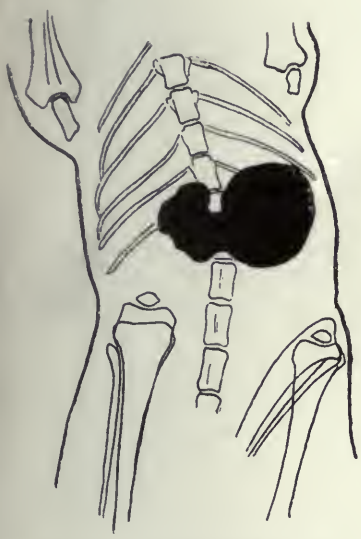


FIG. 173.—Fifteen minutes after meal: before operation.

FIG. 174.—Forty minutes after meal: before operation.

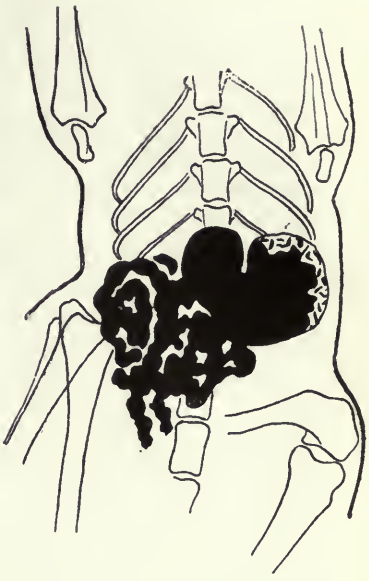


FIG. 175.—One hour and a quarter after meal: before operation.

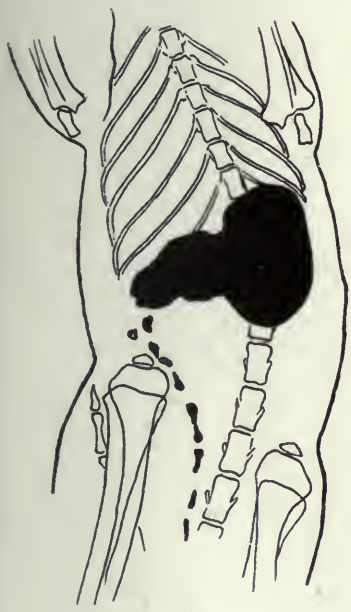


FIG. 176.—Ten minutes after meal: after operation.

FIG. 177.—One half hour after meal: after operation.

FIG. 178.—One hour and a quarter after meal: after operation.

one experiment, on a subsequent occasion. The powerful psychic influences which affect the motility and secretion of the stomach are especially difficult to control. The disturbing effects upon the animals of being taken from their usual feeding place into a dark room with many strange noises, and the restraint necessary to obtain a satisfactory photograph, must tend to vitiate the results; but after carefully weighing such considerations, and after examining several series of radiograms, it becomes apparent that, following a simple division of the pylorus, during the earlier stages of digestion food passes into the duodenum and jejunum more quickly and in greater quantity than in the normal animal. A comparison of *Figs.* 173, 174, and 175, with 176, 177, and 178, illustrates this. On the other hand, I cannot affirm confidently that during the later stages of gastric digestion this acceleration of the passage of food into the duodenum is maintained. In the animal in which the section healed with the formation of a linear scar no alteration in the rate of gastric expulsion was seen.

A Discussion on the Experimental Results and their Bearing upon the Possible Extension of the Operation to Certain Disorders of the Stomach.—In the light of these experimental findings, we may conclude, first, that the operation of simple division of the normal pyloric sphincter leads to a certain initial increase in the rate of passage of food through the stomach, and a probable earlier complete evacuation of this viscus; secondly, that these effects may be temporary or permanent according to the method of healing of the wound. Either tone and function will return to the muscle ring, as it does after a similar incision of the anal sphincter, a narrow linear scar alone remaining at the site of operation; or the partitionary power of the pyloric sphincter will be lost permanently, with perhaps the formation of a shallow diverticulum of the canal. I have not obtained evidence that a vicarious sphincter in the duodenum comes into action when the function of the pyloric sphincter is lost, as Cannon and Blake[1] assert.

Certain subsidiary questions immediately arise in connection with the functional results of such an operation, the answers to which have not as yet been sought experimentally: (1) Is the period of the complete secretory curve after the ingestion of a given meal reduced *pari passu* with the more rapid escape of the chyme from the stomach? (2) Does the earlier passage of stomach contents into the duodenum lead to a similar prompt response in the form of a hasty efflux of the pancreatic and hepatic secretions? (3) Does the operation allow of an increased backflow of duodenal contents into the pyloric antrum?

The answers to such questions would form the considerations which should determine whether or not the operation should be practised in some gastric disorders of man. In this connection it has already proved an unqualified success in the treatment of congenital hypertrophic stenosis of the pylorus, and, because of its success, there are but few opportunities to examine the late anatomical results. Functionally it is clear that the increased ease of evacuation of the stomach is permanent; but it is not so evident that this is due to the persistence of the primary abolition of function of the pyloric sphincter, for Downes[2] was able to examine two children who died from other causes, one, and one and one-half, year respectively after the operation, and he describes the sphincter of the stomach as being normal in appearance, a linear scar alone remaining as evidence of the operation. This observation has been confirmed by Ransohoff (discussion following Downes' paper). It has been suggested that relief is permanent because the hypertrophied sphincter does not increase in size and strength at an equal rate with the rest of the stomach musculature. It is this felicitous law of growth which enables an operation, which in itself gives temporary benefit, to be of lasting advantage.

It is possible that this sphincteric operation might improve the altered gastric function in three clinical conditions. They are the cicatricial contraction following ulcer at the pylorus, the spasm of the pylorus associated with ulcer of the body of the stomach, and hyperchlorhydria. Graham[3] has performed the operation for the first of these conditions, but after-results are still awaited. In the case of spasm due to an ulcer of the body of the stomach, relaxation of the sphincter might lead to earlier evacuation of gastric contents, and a lowering of gastric-juice acidity, due to regurgitation of duodenal contents.

Boldyreff[4] asserts that in hyperchlorhydria the normal reflux of duodenal contents through the pylorus into the stomach does not take place, and this suggests that in such cases a higher percentage of hydrochloric acid is necessary to provide the adequate stimulus to pyloric relaxation. The tone of the sphincter, and so the necessity for such high acidity, would be abolished by sphincteric division. The conditions suggested as forming a profitable field for exploitation of the procedure would call for a permanent diminution of sphincteric control, if any benefit accruing from it were to be lasting. The operation for such cases would have to be modified accordingly. To attain this end, one of two stratagems would probably be effective, judging by analogy of what happens in operations upon the anal sphincter: the interposition of a wedge of omentum between the two extremities of the cut muscle band, or an oblique division of the sphincter.

One other question must be touched upon. Is any harm likely to come from a diverticulum should one form at the site of operation? The answer to this question can only be given after a sufficient trial; but it would seem to be this, that however fraught with danger diverticula may be in the colon or other regions of the alimentary canal, such abnormalities have been recognized for years as occurring occasionally in the duodenum, but their presence has never been correlated with recognizable symptoms.

My thanks are due to Sir Almroth Wright and the departmental directors of the Pathological Institute of St. Mary's Hospital, by whose courtesy I have been afforded facilities for carrying out this investigation; also to Sister C. M. Harrison, of the *X*-ray Department at St. Mary's, for her skill and patience in taking radiograms of the animals.

REFERENCES.

[1] Cannon and Blake, *Ann. of Surg.*, 1905, xli, 688.
[2] Downes, *Jour. Amer. Med. Assoc.*, 1920, July 24.
[3] Graham, *Surg. Gynecol. and Obst.*, xxx, 208.
[4] Boldyreff (quoted by Carlson), *Amer. Jour. Physiol.*, 1915, xxxviii, 248.

OPERATIVE PROCEDURE SUGGESTED FOR THE REPAIR OF COLLATERAL LIGAMENTS OF THE KNEE-JOINT.

By ALEXANDER H. EDWARDS, Glasgow.

Whilst acting as surgeon to the 3rd Scottish General Hospital, two instances of severe injury to the knee-joint came under my care. In each there was extreme lateral movement of the tibia on the femur in both directions whilst the knee remained extended.

In the first case shrapnel was the cause, the wound of entry being situated medially near the line of the joint, while that of exit was laterally placed, extending irregularly above and below the articular margin of the tibia.

The wounds had healed comparatively rapidly as a result of careful primary treatment in France. Radiography disclosed no alteration in bony structures, but showed an irregular piece of shrapnel close to the anterior margin of the medial tibial articular facet. The metal had been localized and removed through an incision somewhat similar to that adopted for the excision of loose cartilage.

On admission, lateral mobility in extension was well marked, and, in addition, it was possible passively to displace the tibia backwards in full flexion of the leg on the thigh, suggesting that the posterior cruciate ligament was ruptured. In the extended position there was no sign of injury to the anterior cruciate ligament. The quadriceps was slightly atrophied from diminished function, but the patella and its ligament of insertion were normal, as also were the muscular and musculotendinous structures in the immediate vicinity of the joint. Hyperextension at the knee was present, though slight in degree; but this was the more significant as the patient had not attempted to bear any weight subsequent to his accident.

The second case was that of a soldier who had fallen into a shell-hole after having been severely wounded in the knee.

On admission to the home hospital his wounds had healed, but there had been some degree of sepsis in the joint. There was difficulty in walking, owing to side-to-side insecurity and to weakness of the quadriceps extensor, which was atrophied considerably. The unnatural mobility and instability of the joint on both sides were outstanding features, but in this instance no evidence of injury to either of the cruciate ligaments was found.

It was obvious that in both these cases the pronounced instability of the joint could only be eliminated by mechanical support or possibly by operative treatment. The musculotendinous structures around the joint were intact; the capsular ligament in both was loosened or stretched posteriorly. It was thought that the best treatment might lie in the direction of operative repair of the collateral ligaments, with perhaps ultimate repair of the injured cruciate ligament in the first case. As some months had elapsed since the reception of the wound, the consideration of repair of the cruciate ligament was delayed, the treatment of the collateral ligaments seeming to be much more important. With this object in view, examination on dead subjects showed that the tendon of the biceps cruris might supply a useful flap, and that this could be reinforced by a flap of the fascia lata; that on the medial aspect the tendons of the semitendinosus and gracilis could be dislocated dorsally and united after separation from their muscle bellies, and that in both instances these could be fixed in suitable grooves of bone simulating the normal structures fairly closely. Recognizing the fact that ligaments play a passive rôle, the desideratum was to produce in each case as nearly as possible the anatomical line of the normal ligament and to construct and insert it securely under normal tension.

The operation was therefore carried out with the knee-joint in the slightest degree of flexion.

Some time ago, Mr. McMurray, of Liverpool, devised an operation for repair of the medial ligament. In this he utilized the sartorius muscle, which seems very conveniently placed for the construction of a new ligament. Still, with all diffidence and respect, it is suggested that it may not be desirable to have the proximal limit of the ligament continuous with an active muscle. Also it seems to the writer that the tendons of the gracilis and semitendinosus make a typical ligament, either singly or together. In the operations described below, both tendons were utilized, so as to eliminate all possibility of weakness; but my friend Professor Waterston, of St. Andrews, is of opinion that one only of these tendons would be sufficiently strong for the purpose. Several months after operation the result as regards lateral stabilization of the knee was quite satisfactory. A moderate degree of stiffness and slight limitation of flexion had been present, due to the original injury and partly to splintage; but these disabilities were never extreme and had considerably improved.

In the first case the use of a posterior knee-cage as recommended by Sir Robert Jones was of great value. The writer has not dealt with a simple case of laceration and destruction of either of these ligaments occurring in civilian practice, but thinks that, in most of these, the operations described below would be more easily applied with satisfactory results than in complicated war injuries.

In cases of extensive injury to the knee-joint, i.e., wherein the collateral and cruciate ligaments have been permanently damaged, the collateral ligaments must, if possible, be repaired first. The cruciate ligaments may be considered later, as the action of these in lateral—i.e., external—rotation of the tibia shows. This movement is in the direction of relaxing these ligaments, or in other words undoes their torsion, so that during this process their only function is that of preventing the separation of the femur from the tibia. But the practical point to note is that, during this phase, both collateral ligaments are normally very tense, thereby maintaining side-to-side stability and apposition of adjacent bones, with prevention of further rotation.

Medial rotation of the tibia on the femur, as is well known, is limited by the torsion of the cruciate ligaments, and at its limit by tensity of the collateral ligaments; so that both rotations of the tibia are controlled by the collateral ligaments, whereas lateral or external rotation is not opposed by the cruciate ligaments; this supports the view suggested, that the collaterals are the more important group in maintaining the stability of the knee.

REPAIR OF THE LATERAL LIGAMENTS OF THE KNEE: THE OPERATIVE TECHNIQUE.

FIBULAR COLLATERAL LIGAMENT (EXTERNAL LATERAL LIGAMENT).

1. Incision to expose the fascia lata, lateral condyle, tendon of the biceps cruris, and the head of the fibula.

2. Make a rectangular flap about 3 in. long from the fascia lata, with its base at the femoral condyle. Fold this flap to make a strong narrow band, and apply some stitches to maintain the folding (*Fig.* 179).

3. Raise a longitudinal vertical flap from the tendon of the biceps, incising the tendon at about the level of the joint: this should be about 3 in. also.

4. Separate the fibrous connective tissue over the lateral condyle, where the ligament is normally attached: draw the margins aside, expose the bone, and gouge out a small cavity about $\frac{1}{4}$ in. deep by $\frac{1}{2}$ in. long, in the vertical axis of the limb.

5. Operate on the head of the fibula in an exactly similar manner, scooping out a groove as before. Now pull forward the biceps flap and insert it into the groove made in the lateral condyle, fix it there with a small staple, and stitch the connective-tissue edges over it (*Figs.* 180, 181).

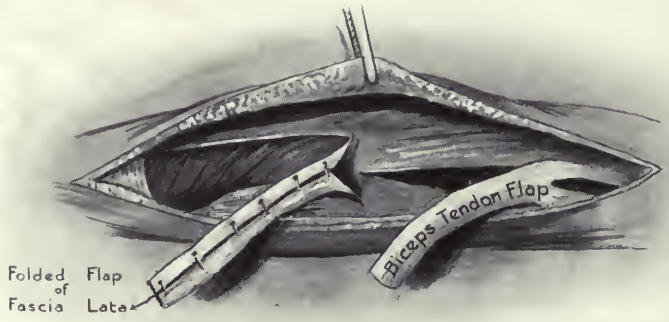


FIG. 179.—The oblong flap formed from the fascia lata has been folded on itself and the edges sutured together, so that it becomes approximately one-third its former breadth and about twice its former strength. The distal flap is raised from the strong fibro-aponeurotic tissue which extends from the biceps tendon of insertion proximally for a considerable distance, on the deep surface of the muscle-tissue proper. The fibroperiosteum on surface of head of fibula has been separated and a depression formed in the osseous tissue of this bone.

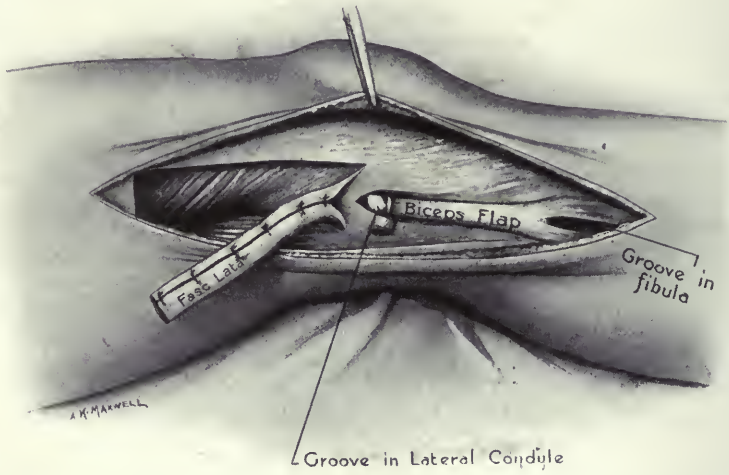


FIG. 180.—Another grooved depression has been formed in the lateral condyle, exactly where the normal ligament was attached. The biceps fibro-aponeurotic flap has been fixed in this, at full tension, by means of a staple.

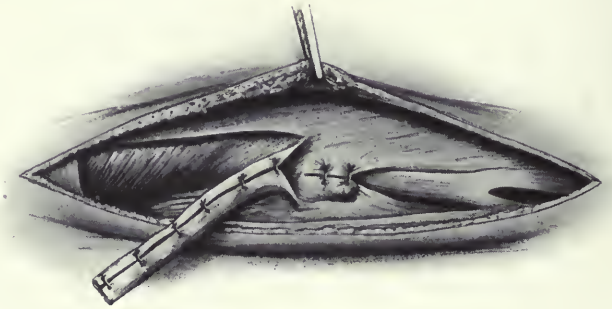


FIG. 181.—The gap over the artificial insertion has been covered by deep fascia; and the proximal or fascia lata flap is ready for insertion into the groove in head of fibula.

6. Turn down the flap from the fascia lata ; insert it into the head of the fibula as above with a staple, etc., maintaining in both instances strong tension whilst fixing (*Fig.* 182).

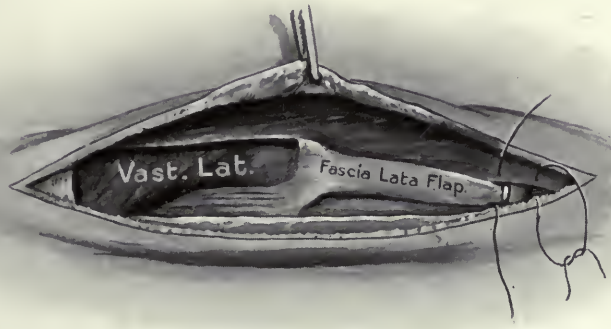


FIG. 182.—The proximal flap has been turned distally, and fixed into the head of the fibula by a staple. Suturing of the deep fascia over the newly-placed ligaments has been begun distally.

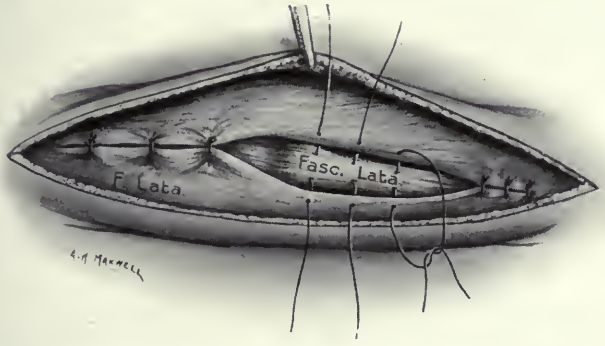


FIG. 183.—The gap in the fascia lata is here closed, as also is the gap opposite the superficial of the two flaps. In the latter the sutures are piercing the flap transversely.

7. Apply a few stitches through both flaps, and then stitch the gap in the fascia lata (*Fig.* 183).

8. Suture over all the deep fascia.

9. Lastly, suture the skin.

TIBIAL COLLATERAL LIGAMENT (INTERNAL LATERAL).

1. Incise along the medial aspect of the knee with the centre approximately at the medial condyle (normal attachment of the tibial collateral ligament) ; continue the incision proximally and distally, exposing the sartorius from the lower end of its fleshy belly to the tendon close to its insertion (*Fig.* 184).

2. Separate the sartorius from the condyle, and expose the gracilis and semitendinosus tendons : by blunt dissection these latter can be separated and pulled forwards.

3. Divide both these tendons at the level of the medial condyle (gracilis and semitendinosus), dissect them from their attachments, and pull them well forwards—caught up in pressure forceps, which have also to be applied to the proximal parts.

4. Make a groove in the medial condyle similar to that in the previous operation, and situate over the point of attachment of the ligament.

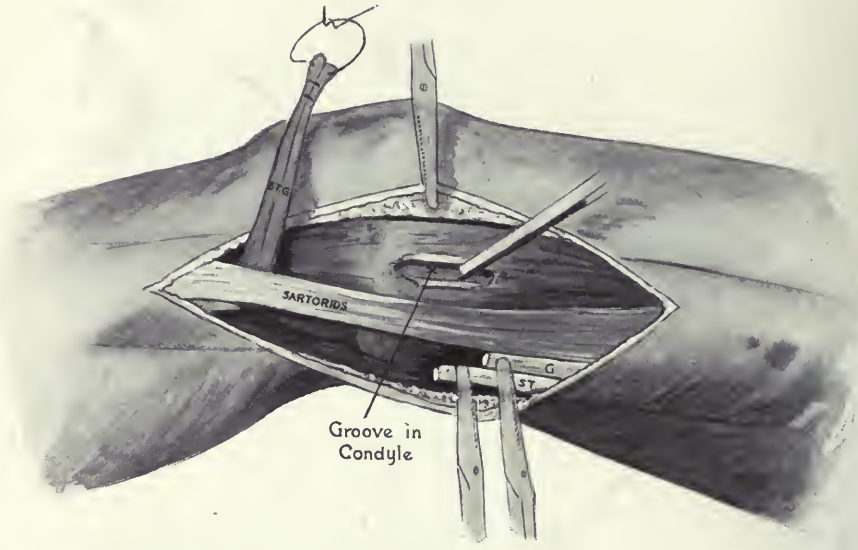


FIG. 184.—Shows the sartorius muscle separated from the deep fascia, after having been pulled ventrally to some extent; the semitendinosus and gracilis tendons are found on the deep surface and ventral to the sartorius. It is important to preserve the deep fascia, especially that ventral to the sartorius. The former is not well defined in the drawing. To prevent retraction the two tendons are clamped proximally before division. Distally the tendons are pulled dorsally and sutured together. The fibroperiosteum has been split longitudinally over the medial condyle, and a grooved depression excavated in the bone underlying it.

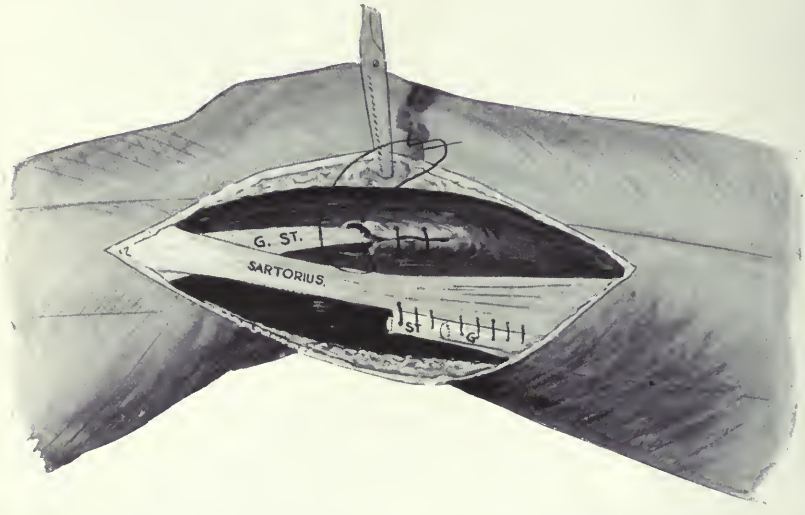


FIG. 185.—The united tendons at full tension are here inserted into the groove and fixed by a staple. The fibroperiosteum is in process of suture over and through the tendons. The proximal sections of the two muscles are distally sutured to the sartorius under moderate traction.

5. Stitch the distal parts of the tendons together, firmly and overlapping; or rather, parallel.

6. After seeing that these are well separated to their insertion on the tibia, and after

pulling them well forwards, it will be found that they are in the long or vertical axis of the limb.

7. Place the proximal end of this distal portion in the groove prepared, and stitch over it the fibrous tissue of the condyle, after having fixed it in the groove with a staple.

8. Suture proximally the gracilis and semitendinosus to the sartorius so that the active contractile function of these muscles is not lost (*Fig.* 185).

9. Suture the deep fascia to the sartorius, which must be pulled well backwards so that the normal line of traction of this muscle (and through it of the gracilis and semitendinosus) is properly maintained (*Fig.* 186).

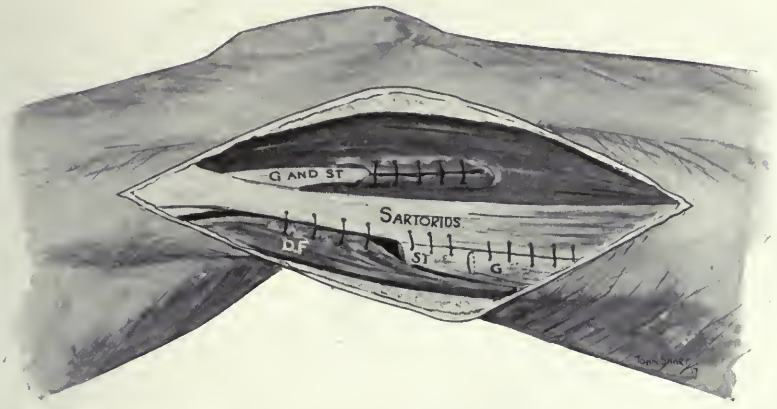


FIG. 186.—The sartorius muscle is pulled as much as possible ventrally, and fixed down with sutures through the deep fascia (D F). More proximally the three muscles united should be drawn also ventrally, and sutured so as to maintain the sartorius, etc., in their normal sites.

10. Close up the subcutaneous areas and skin.

11. It is best to apply a light plaster-of-Paris splint to the limb, extending from the mid-thigh to mid-calf, and let it remain immobilized for about fourteen days.

12. Later, massage must be applied, and in about one month gentle active movements.

Grateful thanks are herewith tendered to Professor Bryce for his kindness in granting the use of the Anatomy Department at the University of Glasgow; to Professor Waterston, St. Andrews University, for a like privilege; also to Professor Walmsley, Queen's College, Belfast, for kind help.

THE TREATMENT OF STIFF METACARPOPHALANGEAL JOINTS WHERE THERE IS NO GROSS BONY ALTERATION.

By JAMES A. DICKSON, Birmingham.

Injuries of the upper extremity, especially those associated with sepsis and nerve lesions, are often followed by stiffness of the metacarpophalangeal joints, usually in the extended position. This condition has been particularly common in cases of war injuries, but also tends to occur as a result of severe industrial accidents.

The fact that this type of disability forms a large percentage of the cases admitted to the pensioners' orthopædic hospitals and clinics points to an incomplete knowledge of its prevention and treatment. It has been suggested that splintage has been mainly responsible for this disability, but the fact that it is a common sequela to nerve injuries and sepsis, even where massage and movement have been carried out from the initial stages, goes to prove that these are independent factors in the production of this condition.

Without flexion of the metacarpophalangeal joints there is a very serious loss of function of the hand, as a good grasp is impossible. Clinically the condition is very characteristic; the metacarpophalangeal joints are held in the extended or hyperextended position, and no voluntary flexion is possible. Any attempt at voluntary movement results only in flexion of the distal phalanges. The condition would appear to be due to: (1) Fibrosis of the joint capsule; (2) Contracture of the extensor tendons or involvement of these tendons in scar; (3) A combination of the above.

A very simple clinical test to differentiate between tendon shortening and fibrosis of the joint is as follows: Pressure is applied on the head of the first phalanx until the metacarpophalangeal joint is flexed as far as possible. If flexion of the interphalangeal joint is then possible, the limitation of movement is due to a capsule condition. On the other hand, if the interphalangeal joints cannot be passively flexed except when extension of the metacarpophalangeal joints takes place, then the condition is one of tendon involvement or shortening. It is interesting clinically to know which is the predominant factor, but it is immaterial as far as the treatment is concerned, as this is identical whether the loss of movement in these joints is due to fibrosis of the capsule or shortened tendons.

The treatment of these stiff joints has, as a rule, been a lengthy procedure, and in many cases has been exceedingly disappointing, not only for the patient but also for the surgeon. We are constantly having referred to Highbury and Uffculme Hospitals cases which have received treatment for months and even years, and were finally discharged to make the best of their disability, although there were in these cases potentialities of a complete recovery. Many attempts have been made to overcome this persistent disability and to shorten the usual prolonged period of treatment. Among the methods advocated are: (1) Gradual flexion while traction is applied to the fingers—banjo method; (2) Division of the joint capsule with fixation of fingers in flexion; (3) Mobilization under an anæsthetic with fixation of the fingers in flexion; (4) Gradual correction by means of plaster.

All these methods have a varying degree of success, but the best results at Highbury and Uffculme Orthopædic Hospitals have been obtained by gradual flexion with plaster. In all methods there is a tendency to relapse when the splintage is removed for purposes of massage, etc.: this has now been overcome by the use of a special 'retaining bar' which is applied between treatments.

The following plan, which has been adopted at the above hospital for the treatment of this type of case, appears to be very effective. The results to date are most gratifying,

and there is no doubt that the usual prolonged treatment can be greatly reduced. What is more important still, relapses are practically nil. The principle of the treatment is that the metacarpophalangeal joints are gradually flexed with plaster; then, by means of the 'retaining splint', this flexion is maintained between the massage treatments until there is full voluntary flexion and no tendency to relapse. The ability to flex the joints voluntarily and retain the flexion is the indication for the removal of the splint. If, with freedom, there is any tendency towards limitation of the flexion obtained, the splint must be re-applied for a further period.

The following illustrations show the method of flexing the joints :—

Fig. 187 shows the plaster case applied to the arm, and the chief features are: (1) The case must be suitably padded, but not too much; otherwise it becomes loose. (2) A short plaster slab is used for the dorsum of the hand and fingers, and another to form a cock-up for the wrist, the plaster being moulded to flex the fingers as much as possible (*Fig.* 187, A). (3) The plaster must incorporate the elbow (*Fig.* 187, C) in order to prevent slipping and thus minimize any tendency of the plaster to cut into the hand during the wedging procedure. This is very important.

FIG. 187.—A, Plaster case applied; B, Case with the anterior portion cut away to allow flexion of fingers; C, Fingers in full flexion.

When the plaster is properly set, and preferably has had a day to dry, the anterior portion is cut away, leaving a plaster cock-up about half-way up the palm (*Fig.* 187, B). Felt pads are then wedged between the posterior slab and heads of the first phalanges. As the metacarpal bone is fixed (in the plaster case), the maximum result of any force to flex the metacarpophalangeal joints, and thus stretch the contracted structures, would be a force acting on the heads of the first phalanx at right-angles to the shaft, an important mechanical advantage which is obtained by this method. A force so applied results in flexion of the joint without any tendency towards impaction of the joint surfaces. The pads are fixed in place by means of a plaster bandage in order to prevent removal. It is seen that the finger-tips are quite free, and the patient is instructed to keep pulling at them to increase the flexion. In two to three days the fingers will be found to be quite loose again. Another felt pad is then added behind the first phalanx, and thus the wedging is carried on until the metacarpophalangeal joints are fully flexed. *Fig.* 187, C, shows the end-result: metacarpophalangeal joints fully flexed. The average time needed to bring a fairly stiff case into full flexion is about four weeks.

The above method of flexing the joints has been found to be most effective, chiefly because a constant pressure could be obtained which could not be interfered with. In ischæmic conditions and those of long standing, it is difficult to obtain the initial flexion

of the joints; but I have not had a case of the type under consideration where it has been impossible to obtain full flexion. When the maximum flexion is reached, the joints are usually left in this position from a week to ten days, in order that any local reaction may subside, and to make sure that the structures are thoroughly stretched. Although the joints have been fully flexed and kept so for some time, and although the joints appear to be quite free, yet if the plaster were removed and the fingers left, within a few hours they would probably tend to relapse into the old position. It is therefore most important that the flexion we have gained is retained, and the method by which this is done is as follows:

FIG. 188, A and B.—Padded bar and metal spring in position, maintaining the flexion of metacarpophalangeal joints.

As shown in *Fig.* 188, the plaster cap and felt pads are now removed, exposing the dorsum of the wrist and hand, but otherwise the plaster case is left intact. A piece of metal with a V cut in the top to act as guide for the wire, is incorporated in the plaster opposite the wrist-joint (*Fig.* 188, A and B), and also another piece of metal with a ring is fixed near the elbow. A leather-covered and padded metal bar is then placed over the heads of the proximal phalanges, and from the centre of this a wire runs between the middle and ring finger over the guide to a metal spring, which is fastened to the ring by means of a tape as shown in the figure. By adjusting the spring, sufficient force can be applied to keep the fingers flexed. Owing to the position of the fingers and the direction of the force, there is no tendency whatever

FIG. 189.—Splint with flexion-bar removed, to allow of massage and movement.

for the bar to slip off the ends of the fingers. Attention is drawn to the fact that the bar rides on the heads of the proximal phalanges, and the pull is approximately at right-angles to the shaft of the bone, which, as pointed out above, is most efficient mechanically.

In *Fig.* 189 the flexion-retaining bar has been removed so that massage and movements may be undertaken. The bar is re-applied after treatment.

After about ten days' treatment, the plaster case is removed and replaced by a short plaster cock-up and a laced leather elbow-case, as in *Fig.* 190. The elbow-case fixes a strap just above the condyles of the humerus to which the spring is fastened. Movements of the elbow are not then restricted on account of the position of the strap. If the spring is tightened when the elbow is flexed, there is only a very slight increase in the tension when the elbow is extended. [It might be mentioned at this stage, that the fixation of the elbow for four to seven weeks in the initial stages has not as yet resulted in any limitation of its movement.] By means of this splint, the metacarpophalangeal joints are kept in full flexion until the normal function of the joints is established. At the same time the patient has full advantage of the various baths, massage, etc. In the final stage, in order to obtain the flexion of the interphalangeal joints, tapes may be used instead of the bar, as shown in *Fig.* 191, A; but they must not be employed before flexion of the metacarpophalangeal joint is assured, because, if the proximal phalanx is in an extended position, the greater percentage of the force applied causes only an impaction, and not any real flexion of the metacarpophalangeal joint (*Fig.* 191, B). As was pointed out previously, the ability to retain the flexion voluntarily is the indication for the removal of the splint, and any tendency to relapse is an indication for further splintage.

FIG. 190.—The plaster case has been replaced by a short cock-up and the spring leather elbow-case, allowing of elbow movements.

FIG. 191.—Final stage: flexion retained by use of tapes. A, The correct position; B, Faulty and useless position for applying tapes.

The following are a few of the points in favour of this method of treatment of the disability in question: (1) Flexion of the metacarpophalangeal joints can be maintained, and at the same time the patient may have the benefits of baths, massage, etc.; (2) The mechanics of the procedure are correct; (3) The apparatus and its application are exceedingly simple; (4) No anæsthetic is required; (5) The time under treatment is greatly diminished and the number of relapses minimized.

The following three cases which have been treated on the above lines are typical examples of the worst kind, and show the initial and final conditions.

FIG. 192.—*Case* 1. J. F. A, Before, B, After treatment.

Case 1.—J. F.—Late Pte.—Admitted to this hospital Oct. 12, 1919. He had sustained a severe gunshot wound of the left wrist in March, 1916. Wounds were healed by June, 1918. He had been having massage treatment for eighteen months before admission. There was much damage to the lower end of the radius and the carpal and metacarpal bones, with resulting ankylosis in the straight position. The inferior radio-ulnar joint was not involved, and *x* rays showed the metacarpophalangeal and the phalangeal joints to be clear. The extensor tendons were involved in the scar.

Fig. 192, A, shows the maximum possibility of closing his hand, either passively or voluntarily, on admission. *Fig.* 192, B, shows his condition on March 1, 1920. Full voluntary flexion and extension were possible.

Case 2.—A. E. J., late Pte.—Wounded January, 1917. Gunshot wound of left forearm. There was no injury to main structures. Wound healed five months after injury. Was admitted to hospital Sept. 14, 1919.

Fig. 193, A, shows the condition, and the maximum degree of flexion possible at that time. In this case the chief difficulty was tendon shortening, but the capsules were also involved. *Fig.* 193, B, indicates the end-result, March, 1920, showing normal range of movement.

FIG. 193.—*Case* 2. A. E. J. A, Before, B, After treatment.

Case 3.—F. E. W., late Pte.—Wounded July, 1916, in right shoulder. Subclavian aneurysm developed a few weeks later, and was tied off. Had treatment up to the time he was discharged about the middle of 1918. He reported at Highbury on

Feb. 4, 1919, with a condition as shown in *Fig.* 194, A. There was a severe ischæmic condition, the hand was distinctly 'griffe', and the metacarpophalangeal joints were hyperextended. There was a fibrosis of the wrist-joint and all the joints of the hand, and practically no movement was possible. Four months were spent with treatment by hot baths and massage, in order to improve the general condition of the circulation in the hand. His wrist was then forcibly moved in plaster, and normal movement obtained. [I should like to point out in this connection that, if both the wrist and metacarpophalangeal joints are involved, it will be found more advantageous to correct the wrist first and, if possible, have it in a position of dorsiflexion before anything is done for the metacarpophalangeal joints.]

FIG. 194.—F. E. W. A, Before, B. After treatment.

On Oct. 12 the plaster case was applied for flexion of his metacarpophalangeal joints, and *Fig.* 194, B shows his condition on March 1, 1920. Full voluntary range of movement was then possible.

The above three cases, which are no doubt examples of the worst of their type, have only averaged from six to seven months before full range of movement was obtained in the metacarpophalangeal joints, and I consider these results speak well for the efficiency of this method of treatment.

REGIONAL ANÆSTHESIA, WITH SPECIAL REFERENCE TO 'SPLANCHNIC ANALGESIA': A NEW METHOD APPLICABLE TO ABDOMINAL SURGERY.

By Dr. GASTON LABAT.

Every abdominal operation consists of two steps: (1) *Laparotomy* (incising the abdominal wall); (2) *Dealing with the diseased viscus.*

1. **Laparotomy.**—This has been performed under local anæsthesia since the days of Reclus and Schleich. These pioneers made use of infiltration of the line of incision. Sellheim, in 1905, attempted to anæsthetize the anterior abdominal wall by injecting the nerve-roots close to the spine, from the eighth dorsal to the first lumbar; but, according to Braun, the results were not very encouraging. In 1911, Laewen, making use of a method of his own, devised from Sellheim's experiments, published a series of successful cases, and called the method *paravertebral conduction anæsthesia.* From that time onwards many authors, among whom are Finsterer, Braun, Kappis, Allen, Harris, Fischer, Kroenig, Siegel, Kimpton, Victor Pauchet, Sourdat, Labouré, and ourselves, employed this method with varying success; but finding it tedious to the anæsthetist and trying to the patient, a certain number of experiments were conducted with a view to finding a simpler method.

2. **Dealing with the Diseased Viscus** by local anæsthesia has now been proved to be possible only when the deep injections are made along the line of the sympathetic chain, where the rami communicantes join the sympathetic nerves. In 1917, Wendling (of Bâle), in his thesis, reported twenty-seven cases in which anæsthesia for various gastric operations had been obtained by injecting 50 to 80 c.c. of a 1 per cent novocain solution through the anterior abdominal wall into the solar plexus or its vicinity. The abdominal wall having been rendered insensitive by a local injection, the needle was inserted through it, piercing the left lobe of the liver and the gastrohepatic omentum, and reaching the neighbourhood of the solar plexus.[1] Allen and Victor Pauchet had obtained the same result by the much safer and simpler process of injecting a smaller quantity of novocain-adrenalin directly into the solar plexus after opening the abdomen.[2]

But these procedures are sometimes very difficult. In stout individuals with tense rigid abdominal walls, as soon as the abdomen is opened, the contents bulge out, and even the packing back is not always a very easy task. In thin relaxed patients it is usually possible, when much gentleness is used, to slip in two fingers, thus opening the way for the needle to the solar plexus or the retroperitoneal tissue in its vicinity, care being exercised in the neighbourhood of the large vessels. Even under the best conditions, the technique is only possible in the hands of those who have acquired sufficient experience of the local methods within the abdominal cavity.

Taking up the subject, we were prompted to seek to improve upon this technique for two other reasons: (*a*) It is much more convenient both for the patient and the surgeon that the anæsthesia be completed before the operation is commenced; (*b*) Because the results so far obtained were by no means constant.

In the meanwhile, Naegeli and Kappis, experimenting independently of each other, endeavoured to find a route to the splanchnic nerves through the posterior abdominal wall. Naegeli, in 1919, published eighteen cases, most of which were successfully anæsthetized by his method.[3] We had already been led to select a posterior route as the best means of anæsthetizing the upper part of the abdominal cavity, not because we believed

that the solar plexus or the splanchnic nerves were the sole or the chief paths of conduction of painful impulses, but because, in our opinion, pain in gastric operations is chiefly due to traction on the parietal peritoneum, resulting in the cleavage of the retroperitoneal tissue, which is richly supplied by cerebrospinal nerves.

Adopting the site of injection advised by Naegeli, we have devised a technique by means of which a complete anæsthesia of this tissue is obtained, and thus all operations on the upper part of the abdominal cavity can be painlessly performed. It is with a description of this method that we are chiefly concerned in this paper.

PRINCIPLES.

The Method.—Most of the patients sent to the surgeon for operation on the abdominal organs (stomach, liver or gall-bladder, and intestines) are in such a state of lowered resistance that it is often a question whether it would be justifiable to incur the risks of a general anæsthesia. These patients are auto-intoxicated to such an extent that the normal metabolism and the oxygenation of the blood are considerably altered, thereby interfering with the essential requisites of any general anæsthesia. In such cases the advantages of regional anæsthesia are obvious, inasmuch as its main effects are limited to a relatively small region of the body, leaving intact the central nervous system, upon the integrity of which depends the continuance of all the vital functions.

The Patient.—The degree of pain is not proportional to the intensity of the trauma. Individual differences are well marked. They depend upon many factors, among which the emotional play the chief part. Nervous excitement, specially due to apprehension, may be so great in some patients as to interfere even with the necessary manipulations of the local method. By these patients a slight touch is often interpreted as pain. It is therefore advisable, as a general rule, to blunt their consciousness, and for this purpose scopolamine and morphine have proved to be the best. We inject a solution containing scopolamine $\frac{1}{4}$ mgrm. and morphine 1 cgrm. one hour before commencing the anæsthesia. The injection of a smaller dose, or of the same dose at a later stage, acts on some patients rather as an excitant than a sedative. The patient should, immediately after the injection, be kept quiet in a darkened room. From this time onwards he should be handled as gently as possible, and every unnecessary stimulation carefully avoided.

The Anæsthetic.—Cocaine was the substance first used for local anæsthesia by Reclus and Schleich; but even these observers rejected it later on in favour of novocain. The analgesia produced by novocain is delayed, and of relatively short duration. It is therefore necessary to add some adrenalin to it, which accelerates its effects and renders it as active as cocaine.

For the purposes of regional anæsthesia it is necessary to inject a large quantity of fluid. With a view to reducing this quantity, a small proportion of cocaine was added to the novocain, expecting thus to obtain a reinforcement of the latter. A solution containing 0·1 grm. of cocaine and 0·9 grm. of novocain per 100 c.c., in doses of from 100 to 125 c.c., produced symptoms of intoxication (nervous excitement, cardiac distress, laboured breathing, pallor of the face, collapse; while in some cases the effects were limited to talkativeness, shouting, and singing). The reduction in the amount of liquid injected was negligible; but the duration of the anæsthesia was increased. A solution containing only cocaine (0·5 per cent) gave rise to even graver symptoms when about 40 c.c. had been injected. On the other hand, 100 to 125 c.c. of a 1 per cent pure novocain and adrenalin (25 drops per 100 c.c.) solution, injected systematically in a series of over 1000 cases, never produced any untoward effects, and the duration of the anæsthesia proved sufficient even for the longest operations.

We have thus been led to infer that *pure novocain-adrenalin solutions are the safest*, that *novocain-cocaine mixtures are dangerous*, and that *pure cocaine solutions should never be used in regional anæsthesia*.

The Anæsthetist.—Gentleness is the first requisite of the anæsthetist. Before anæsthesia is begun, the patient should be warned that he will feel but a few light pin-pricks;

but that all the subsequent operative manœuvres will be painless, although the sensation of touch will not be abolished. If he wishes to be unconscious of what is going on, his ears should be stopped and his eyes bandaged.

The anæsthetist should handle his needle and his patient with equal dexterity. His anatomical knowledge should be perfect, especially so far as nerve distribution is concerned. He should know how best to gain access to the nerve he wishes to anæsthetize. It is unnecessary to lay stress on the importance of asepsis. Needles and other instruments should be tested before use, to make sure of their efficiency. Anæsthetic wheals should be made wherever the skin is to be punctured. Bones serving as deep landmarks should be approached lightly with the needle, since the periosteum is very sensitive. The needle should never be previously fitted on to the syringe when it has to be introduced in the vicinity of large vessels. Before infiltrating, it is advisable to aspirate, in order to ascertain that the point of the needle is not lying in the lumen of a blood-vessel. If this is the case, draw the needle back a few millimetres and change its direction before proceeding any further. A small hæmatoma caused by the accidental wounding of a blood-vessel is of no importance. The injection should be made slowly, and the aspiration test renewed at intervals.

The Surgeon and his Assistants.—The surgeon should wait at least ten minutes to obtain the full anæsthetic effect. He should inspire his patient with confidence, make sure that the latter is lying at ease on a soft cushion, with as little restraint as possible, so that he will be able to undergo the operation with the minimum of discomfort. The patient should not be told when the operation begins. Sharp instruments should be used: cutting with the scalpel should be preferred to snipping with the scissors. On no account should the tissues be torn through or bruised by rough handling. Retractors should be introduced lightly and opened out gradually. Pulls on the viscera should be light and gradual. The organs should not be unnecessarily drawn out of the abdominal wound.

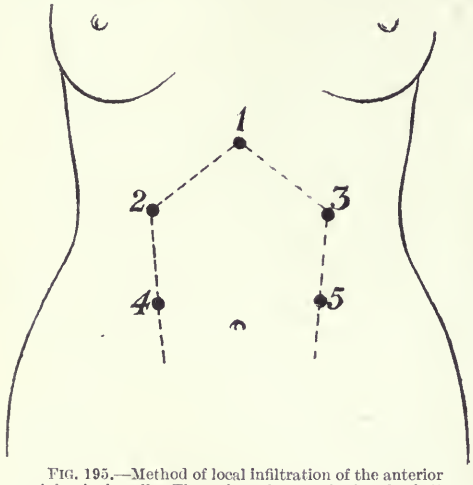


FIG. 195.—Method of local infiltration of the anterior abdominal wall. Through each anæsthetic wheal (1 to 5) the needle is inserted and pushed within the rectus sheath, where the solution is distributed fanwise. The needle is then passed into the subcutaneous tissue parallel to the skin surface, and infiltration made along the dotted lines.

With these preliminary general remarks, we may now pass on to the description of our method for producing 'splanchnic analgesia'.

TECHNIQUE.

Local Infiltration.—Raise five anæsthetic wheals: (1) The first, at the tip of the xiphisternum; (2, 3) The second and third, one on each side, at the level of the tenth costal cartilage, where the external border of the rectus crosses the costal margin; (4, 5) The last two, one on each side, on the external border of the rectus, a little higher than the umbilicus (*Fig.* 195).

The needle (8 or 10 cm. long) is then passed through each wheal in turn, and infiltration made fanwise. The deep layers should be infiltrated before the more superficial. The solution is injected within the rectus sheath (*Fig.* 196): this is quite sufficient to anæsthetize the underlying peritoneum, and gives a good relaxation of the abdominal wall. The infiltrated area should be lightly massaged to spread the solution within the tissues.*

* This technique, first introduced by BRAUN, VICTOR PAUCHET, and SOURDAT in 1914, is the one generally adopted for minor operations. Combined with that of splanchnic analgesia, it constitutes our method of regional anæsthesia in major abdominal surgery.

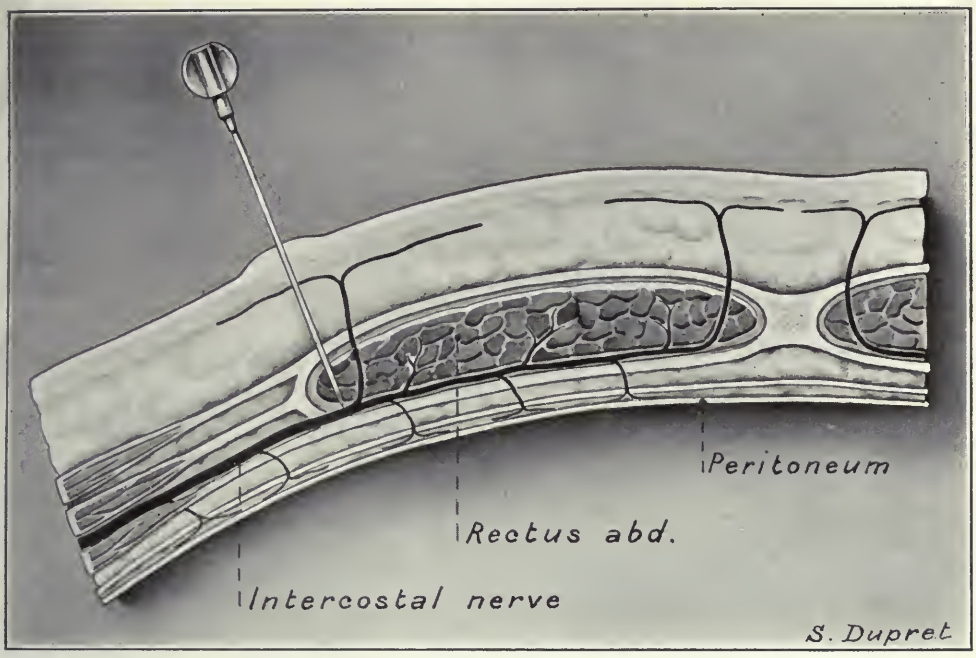


FIG. 196.—Cross-section of part of the anterior abdominal wall, showing the method of making deep injections within the rectus sheath.

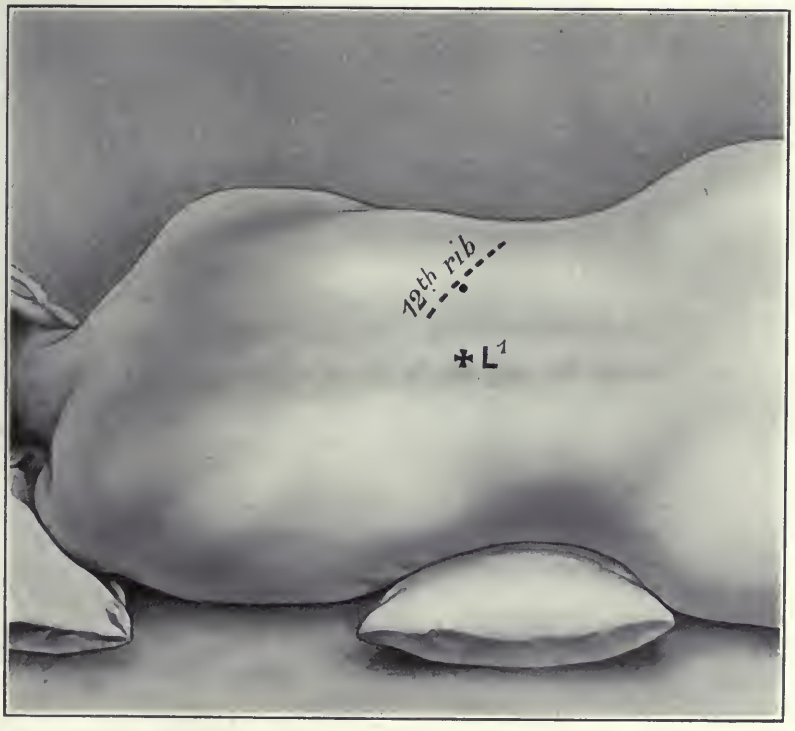


FIG. 197.—Position of the patient for splanchnic analgesia. The point just under the 12th rib marks the site of puncture, and the cross, vertically under, is the spinous process of the 1st lumbar vertebra. The distance between the two is four finger-breadths or 7 cm.

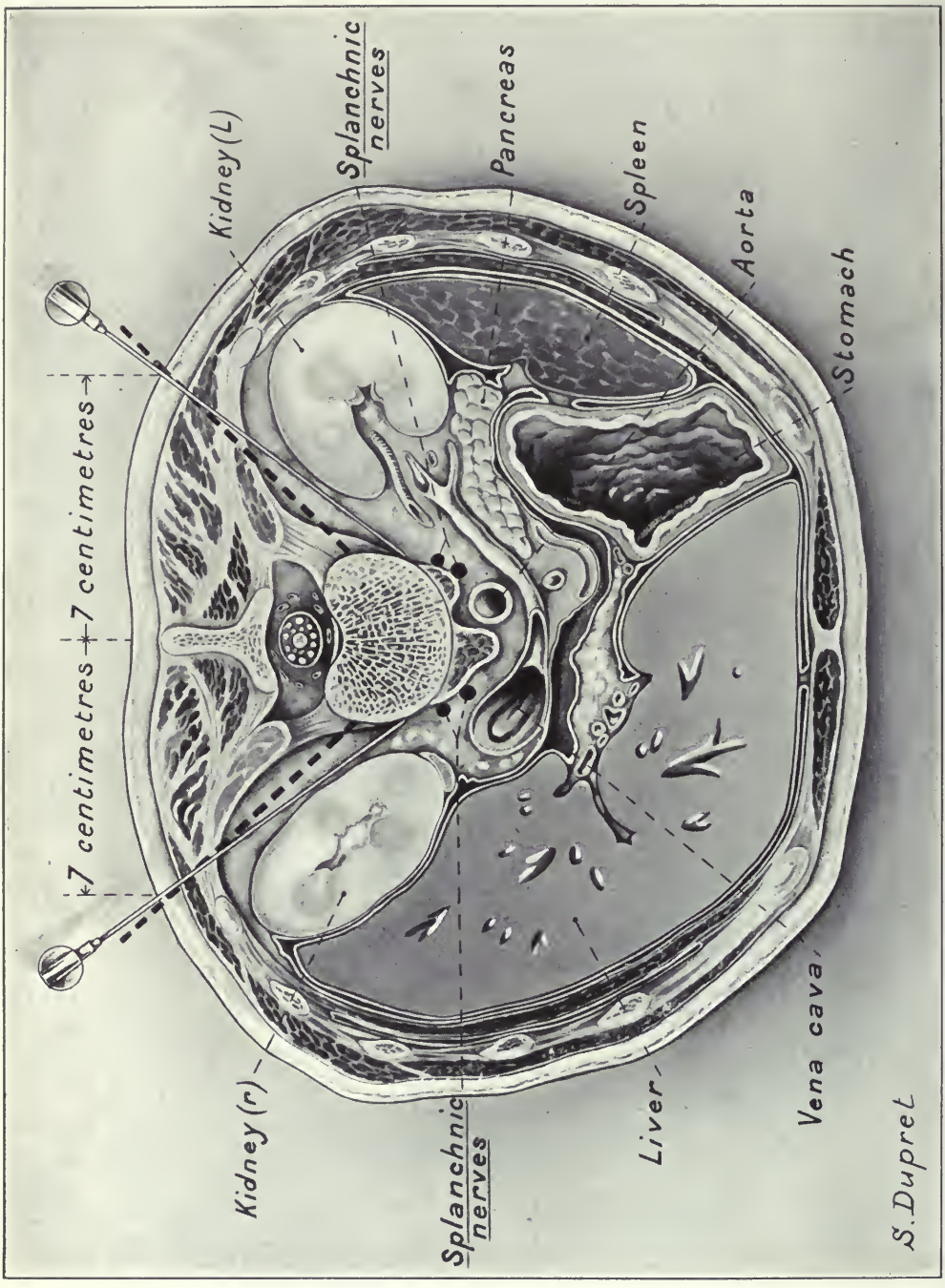


FIG. 198.—Cross-section through the 1st lumbar vertebra, showing the method of inducing splanchnic analgesia. The needle has been inserted on the lower border of the 12th rib, 7 cm. distant from the median line of the back. The dotted line marks the direction of the needle introduced towards the spine at an angle of 45° with the median plane of the body. Note its point of contact with the vertebra: the needle is here in its last and good direction: tangent to the body of the vertebra.

Splanchnic Analgesia.[4]—The patient should lie on his side with the back arched: '*position en chien de fusil*'. Place a cushion under the loin if the spine is too much bent sideways: the relaxation of the muscles thereby obtained renders the landmarks more accessible, and makes the subsequent steps of the technique easier (*Fig.* 197).

Define the 12th rib and the 1st lumbar spinous process. On the lower border of this rib, four finger-breadths or 7 cm. from the middle line of the back, raise an anæsthetic wheal, through which pass a *needle 12 cm. long*, along the horizontal plane of the body, i.e., vertically to the table on which the patient is resting.

Introduce the needle obliquely forwards, so that it makes an angle of about 45° with the median plane. Its point then strikes the body of the vertebra near its anterior convexity,* behind the splanchnic nerves, just where these join the semilunar ganglion. When the needle, introduced for about 9 cm., has struck the bone, it should be drawn back until its point lies in the subcutaneous tissue (so as to be able to change its direction), and reintroduced at a smaller angle. If its direction is good, the needle passes tangentially to the body of the vertebra (*Fig.* 198).

As soon as the point of the needle is felt to glide along the surface of the vertebra, it should be pushed in *one centimetre further*; and, after making sure that no blood comes out of the needle, inject at this level 25 to 35 c.c. of a 1 per cent novocain-adrenalin solution (novocain 1 grm., adrenalin 25 drops of a 1–1000 solution, and normal salt solution 100 c.c.). The patient is then asked to change side, and the injection is repeated on the opposite side.

The solution spreads easily into the loose retroperitoneal tissue, diffusing in all directions, reaching the solar plexus and its immediate tributary as well, thus anæsthetizing a wide area in which all operative manœuvres become painless. But we should not lose sight of the fact that novocain produces, beyond its field of action, a ring of hyperæsthesia, on which distant pulls may give rise to painful impulses, thus bringing about the tendency to believe that the technique has proved a failure.

RESULTS.

We have employed this method 34 times in various abdominal interventions, especially for gastric operations. Resections were performed in 24 cases by Prof. Victor Pauchet, with 21 good anæsthesias.

Operations	Anæsthesias		
	Good	Fair	Bad
Gastrectomy for ulcus	16	1	2
Gastrectomy for cancer	5	—	—
Balfour operation	1	—	—
Ileosigmoidostomy	3	—	—
Gastro-enterostomy for inoperable cancer ..	2	—	—
Radium application for inoperable cancer of stomach	—	1	—
Cholecystectomy	2	—	—
Cæcocolostomy	1	—	—
Total	30	2	2

We noted, either at the precise moment of injection or appearing a little later, a slight acceleration of the pulse, and, in one case, bilious vomiting with slight cardiac distress. These symptoms were of very short duration (two to five minutes), and were

* The anteroposterior diameter of the 1st lumbar vertebra measures about 7 cm. in the adult. The distance between the posterior extremity of that diameter and the point of introduction of the needle measures also 7 cm. These represent the sides of a right-angled triangle; and the needle, having been introduced at an angle of 45°, lies along the hypotenuse of that triangle, no allowance being made for the thickness of the soft tissues covering the spine.

followed by no untoward effects. In two instances a partial anæsthesia of the lower limbs was obtained, due probably to want of technique at the very outset of our experiments. The last series of 25 cases was gone through without the slightest trouble to any concerned.

The many difficulties attending the performance of complicated and extensive operations in the abdomen render it absolutely impossible to rely on the ordinary local method, though the poor and weakened conditions of some patients often urge on the surgeon the importance of inducing regional anæsthesia.

This method is easy, simple, and safe, and should be attempted as often as possible. With the hope that it may be tried with every chance of success, we have here endeavoured to give a clear description of our technique. The results we have obtained are very suggestive, and give a good idea of the possibilities of abdominal surgery under 'splanchnic analgesia'.

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BENIGN AND MALIGNANT CHANGES IN DUCT EPITHELIUM OF THE BREAST.

By Sir G. LENTHAL CHEATLE, London.

The evidence in support of the proposition which I put forward tentatively nearly fifteen years ago,* that cancer begins most commonly in the ducts of the breast rather than in the acini, has accumulated to such an extent, in my experience, that it should carry conviction to the minds of many who were disposed to be sceptical at the outset.

In a paper read before the Royal Society of Medicine on May 13, 1914, I elaborated the proposition by showing that cancer arises in cysts which are of duct origin. In a further investigation of this subject, in the October, 1920, number of this Journal, I was

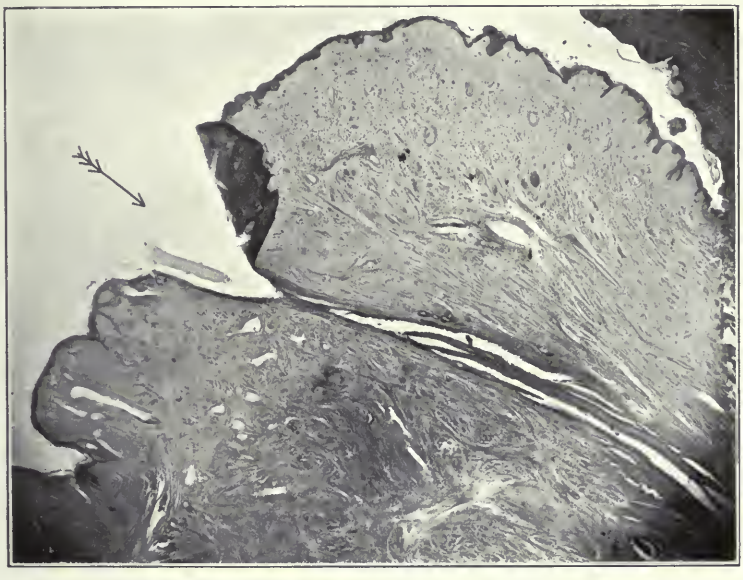

Fig. 199.—Longitudinal section of a duct at its termination on the surface of the nipple. It is part of a whole section. The right half of the tissue forming the exit has turned over.

mainly concerned to demonstrate: (1) That breasts which are clinically described as cystic are dangerous; (2) That dangerous cysts are of duct origin; and (3) That the cystic origin of cancer leads to microscopical appearances which are diagnostic in character.

Before passing on to the main thesis of my present paper, I wish to prove, by photographs of sections, some statements made in my previous communication to this Journal.

First, I wish to add force to the urgency of protecting ducts from the entrance of living or lifeless irritants. *Fig.* 199 is a photograph of a duct opening on to the surface of a nipple. The orifice seems to invite the entrance of an irritant if presented at this part.

* *British Medical Journal*, 1906, May 26.

Far be it from me to make any positive assertion; but the appearances observed in the specimens I describe later, suggest to me a possibility that the cause, or part cause, of the diseases may gain entrance into the ducts through the nipple, and then initiate

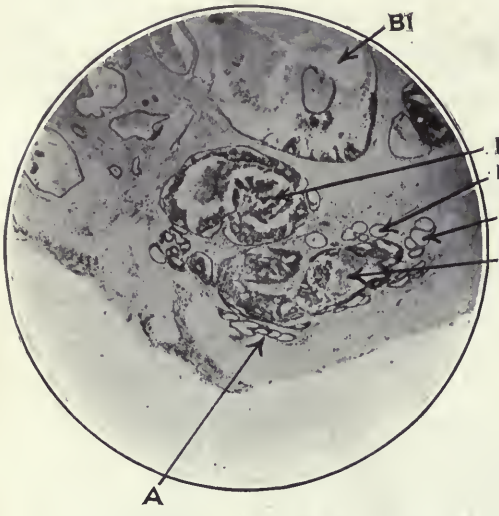

FIG. 200.—Ducts (A; B_1, B_2, B_3; C; D) whose convolutions make them appear separate as cysts when cut longitudinally.

FIG. 201.—Ducts (A; B) cut nearly longitudinally and appearing as separate cysts, showing the same thing as previous figure.

pathological changes. Not only do the appearances suggest it, but the fact that only a few of the ducts are primarily implicated points in the same direction, and it could partly account for the localization of benign and malignant diseases.

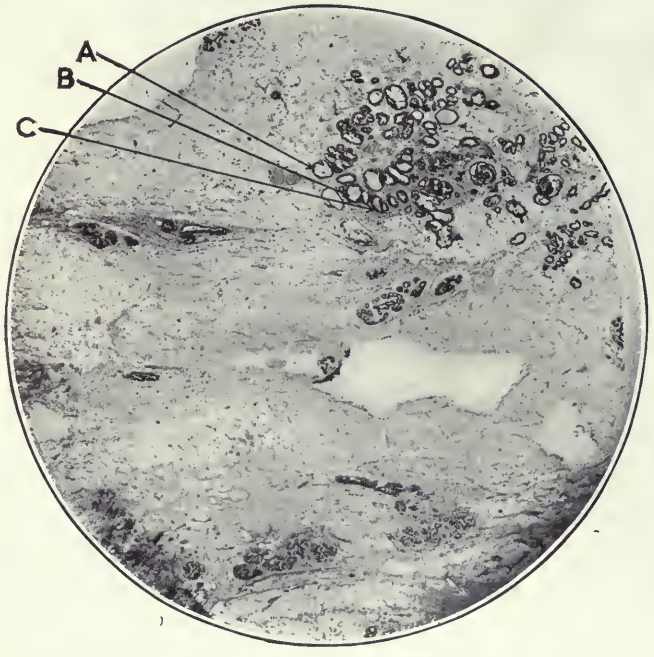

FIG. 202.—Duct which has divided into three convoluted branches, A, B, C, which have been cut longitudinally and give a false impression of being a collection of cysts.

Secondly, by means of serial sections I am able to show that duct cysts, whether they contain simple or malignant growth or no growth at all, must not be regarded as separate cysts, since they are parts in continuity of dilated and convoluted ducts: if they are cut transversely there may be the appearance of single cysts, and if cut longitudinally they may seem to be cysts in a row more or less straight. It may be contended, therefore, that the maintenance of my proposition involves the abandonment of the word 'cyst', but for the present it is more convenient to retain the common clinical nomenclature.

FIG. 263.—A section at the edge of a breast. It is the same section as represented in *Fig.* 100 in my previous article, but I have schematized the cysts into their component parts of ducts, from serial sections. There is 'infiltration' of the parts outside the ducts, at A for instance.

In *Fig.* 200 the five cysts at A are parts of one duct, so are the big cysts B_1, B_2, B_3, which are cancer-containing. The four cysts at C and the three at D are all parts of two ducts cut longitudinally. *Fig.* 201 shows five cysts at A and five at B that are

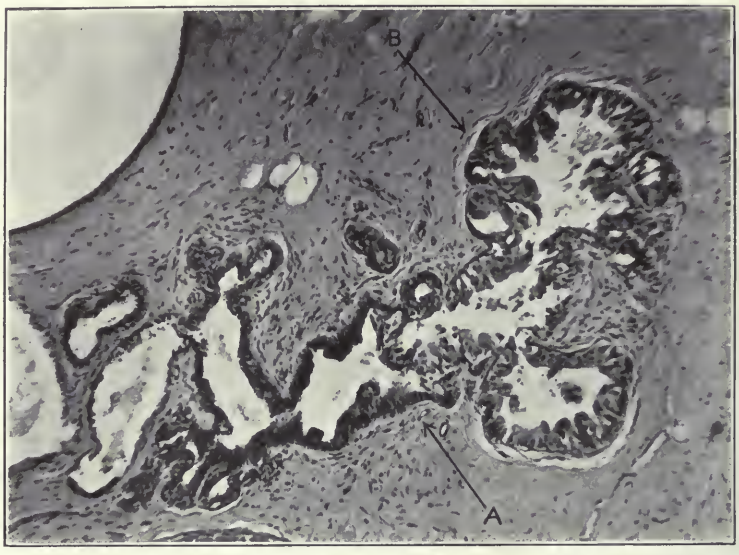

FIG. 204.—An acinous cyst. The duct epithelium is ending abruptly at the dilated acinus, the cells of which have become elongated and feathery. A, Termination of duct; B, Acinus.

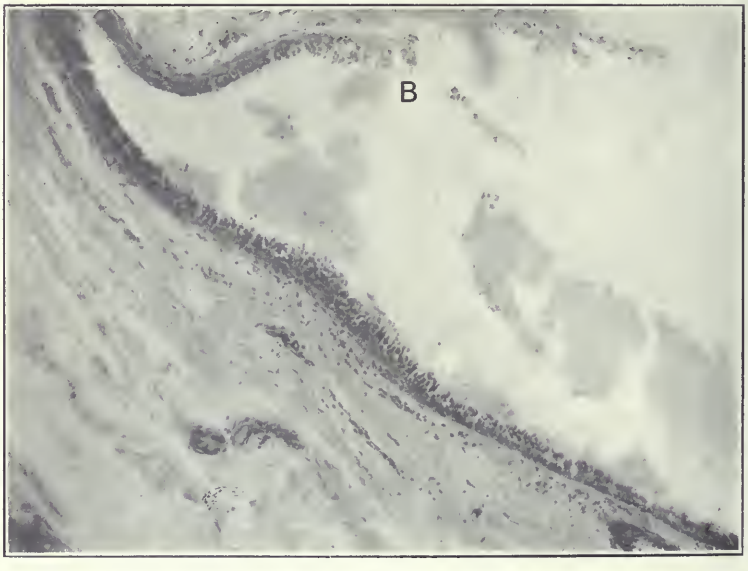

FIG. 205.—Part of a duct cut longitudinally. The epithelium has assumed the elongated and feathery appearance at B.

parts of two different ducts. Five large cancer-containing cysts in *Fig.* 221 belong to one duct. Three chains of cysts in *Fig.* 202 are three separate branches (A, B, C) of a duct that have been cut longitudinally and give rise to the false impression of being a

collection of about twenty cysts. And the great branching cancer-containing duct schematized in *Fig.* 218 gives rise to the false impression in those sections from which it was delimited as being full of separate cysts of various shapes and sizes. The cancer-containing cavities in *Fig.* 203 I have traced on lines which show them in their true light as being only parts of ducts. This section appeared as *Fig.* 100 in my previous paper. In the rest of the section there are cancer-containing branches of ducts I am unable to trace in this plane, and the rest of the specimen shows 'infiltration' only, at A and elsewhere. When once pointed out, it is obvious that duct cysts are parts in continuity of convoluted ducts, and the point needs no further demonstration.

FIG. 206.—Duct lined for the most part by normal epithelium. The epithelium lining the rest of it has undergone the elongated and feathery changes seen in the two previous figures.

Thirdly, I wish to illustrate my difficulty in determining, without the study of sections in series, the origin of those cysts containing the beautiful elongated feathery cells lining them and their papillomata. They might be either duct or acinus. *Fig.* 204, a photograph of a cyst delimited in serial sections, shows an acinous cyst. It is terminal, and the duct epithelium is ending abruptly when the acinus is reached. *Figs.* 205 and 206 show ducts lined in parts with the same feathery elongated cells; and they explain my difficulty in determining the origin of a cyst lined by cells of this kind without confirming the evidence by means of serial sections.

FIG. 207.—A simple papilloma growing from the wall of a duct. It is the only duct papilloma to be seen in a large cystic breast from which whole sections were cut.

The thesis of my present paper I divide into two parts. *Part I* demonstrates the great variations in the number of benign duct papillomata that may be contained in breasts. *Part II* deals with primary malignant disease in ducts. A comparison is drawn, where possible, between the tumours referred to in the two parts.

Part I.—BENIGN DUCT PAPILLOMA.

A.—*Fig.* 207 is a photograph of a benign duct papilloma, the only tumour I was able to discover in whole sections made from a cystic breast. Its presence was totally unsuspected clinically. This specimen I take to be a

benign affection which is represented as malignant disease in two breasts containing single tumours of duct cancer which I shall describe later.

B.—Fig. 208 shows a cystic breast (kindly sent to me by Mr. Sampson Handley for examination) in which two ducts, distributed on opposite sides of the breast, are full of multiple papillomata throughout their courses from the periphery at E E to the nipple at C. Most of these papillomata are benign, but in three separate parts the duct contents are cancer from which the surrounding small isolated areas of cancer have been derived. There was an occasional discharge of blood from two ducts. The papillomata varied in size. The two biggest existed in ducts below the nipple, A and B (each of which may be situated in a dilated ampulla); below this the variation in size was not great —they were microscopical. Macroscopically, the larger of the two above mentioned was a soft diffluent mass whose fine and beautiful papillomatous structure became obvious only on microscopical examination. In some of the cysts the branches of neighbouring

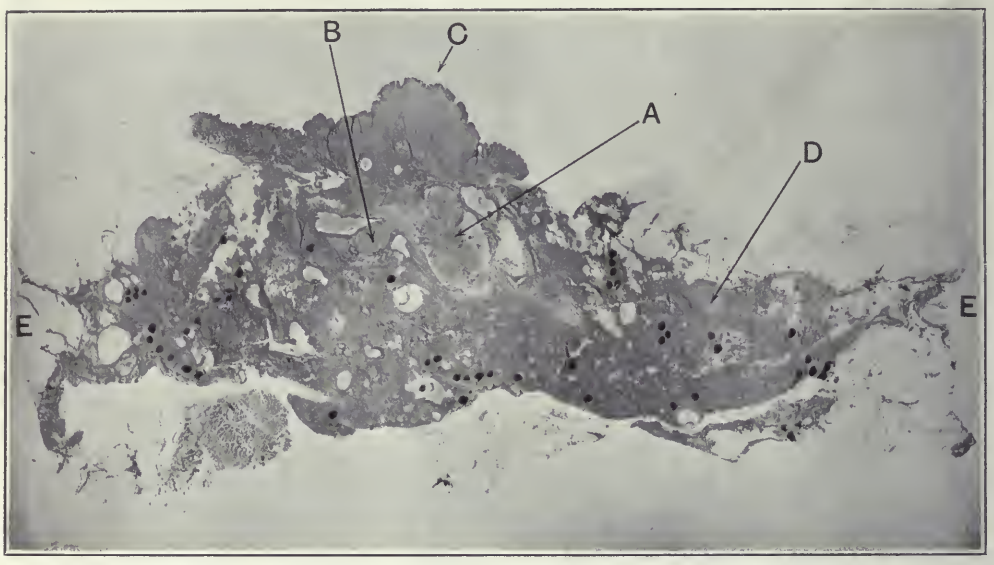

FIG. 208.—A whole section of breast in which more than fifty simple papillomata can be counted. The biggest are A and B. The rest are microscopical; I have marked their situations by dots. Over twenty sections of this breast have been cut, and two ducts so far appear to be mainly concerned in the tumour-growing process; the examination is incomplete. The biggest papillomata (A and B) may be in dilated ampullæ of the duct. C, The nipple. EE marks the periphery of the breast.

papillomata coalesced and formed arches over the underlying normal columnar cells lining the ducts. In some parts the papillomata appeared to possess no central fibrous tissue where they sprang from the walls of the duct, and looked as if branches of papillomata had dropped on to the walls of the duct and their epithelium had coalesced with that lining the ducts. There are more than 70 papillomata. The enormous number of tumours contained in the ducts of this breast form a striking pathological picture. The specimen from which *Fig.* 208 is reproduced I take to contain mainly a benign affection which is represented as diffuse malignant disease in many breasts I shall describe later.

I shall allude to this specimen again, because it contained cancer.

For the purposes of this paper I take the two breasts shown in *Figs.* 207 and 208 as examples of the two extremes in which the gland may be affected by benign papillomata. The reader must bear in mind that there are other breasts in which the number occupies an intermediate position between these two extremes.

Part II.—PRIMARY DUCT CANCER.

In all the specimens I am about to describe, the lymphatic system was invaded by 'infiltration'; in many of them the axillary glands were affected.

A.—First I shall describe two very similar tumours which existed in two patients. They are the only signs of primary tumour formation to be observed. They are very large, and are composed mainly of structures papillomatous in type, but the laciform type I described in my previous article can be observed in minor degree.

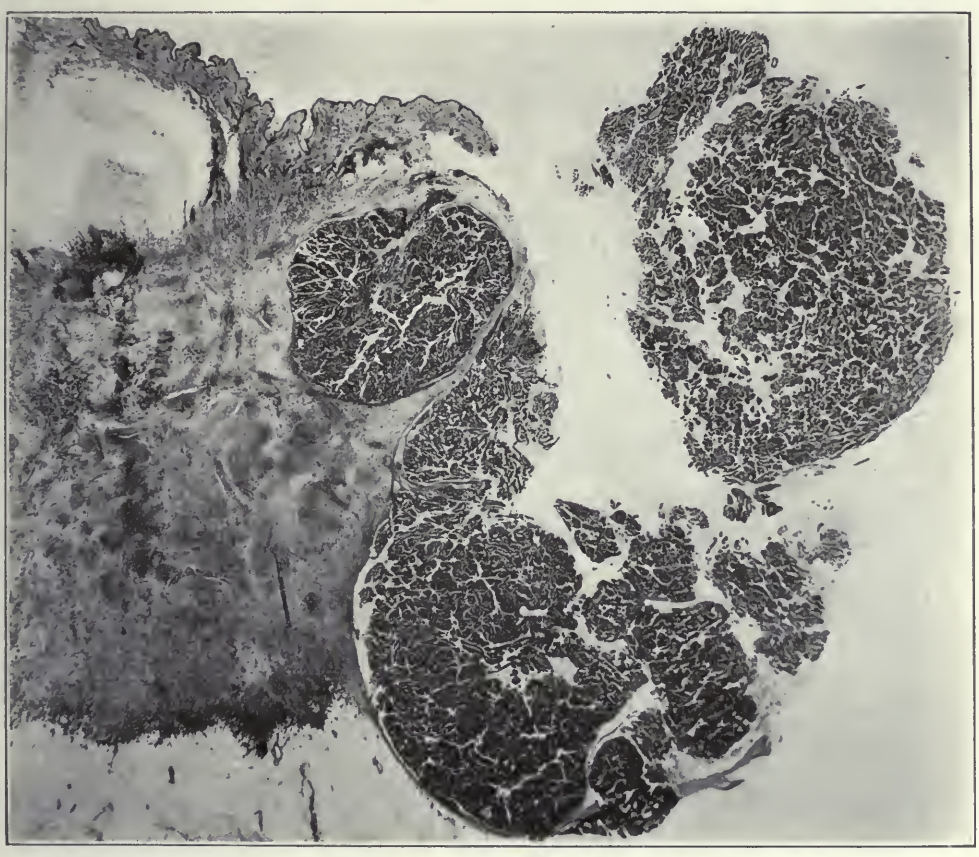

FIG. 209.—Whole section of breast. A large duct cancer occupies the right of the specimen, and an extensive area of 'infiltration' is seen on the left.

The first specimen is shown in *Figs.* 209, 210, 211. *Fig.* 209 shows the tumour on the right, and its 'infiltration' of the lymphatic system on the left. *Fig.* 210 is a high-power photograph of the tumour. *Fig.* 211 is a high-power photograph of the 'infiltration'. The last shows well what always occurs when this and all other forms of duct cancer 'infiltrate' the lymphatic system: they lose their columnar shape, and become 'spheroidal', 'cuboidal', etc., and show no signs of a papillomatous arrangement; this appears to me to be so definite a fact that I need not allude to it any further; it may be taken that the 'infiltration' of all duct cancers which I have observed behaves in the same way.

The second specimen, *Fig.* 212, is the only sign of primary growth in this breast. There is 'infiltration'. Under low power the structure and fabric of this tumour appear

identical with the first specimen, but under high power the cells in most of its parts, even in the tumour itself, have lost all except a hint of their columnar type. In some parts, however, at A for instance, they are definitely and unquestionably columnar. This specimen indicates that the columnar cells in a primary duct cancer growth itself may undergo reversion to a possibly lower type, 'spheroidal', 'cuboidal', etc., in shape.

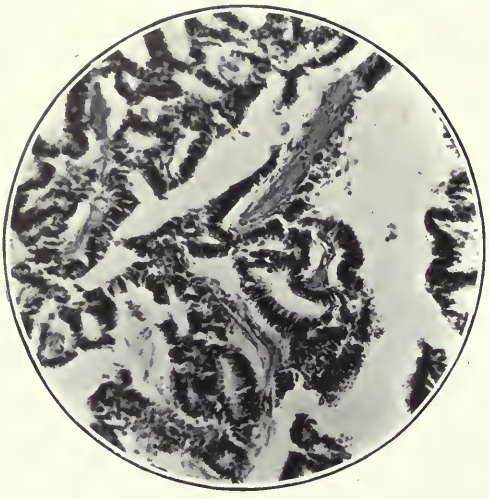

FIG. 210.—High-power photograph of the tumour seen in *Fig.* 209.

I take these two specimens as representative of a malignant type comparable with the non-malignant type in *Part I, A.*

B.—I now attempt to demonstrate two facts, or what I conceive to be facts: (1) That the primary cancer process transforming epithelial into malignant cells may commonly operate on extensive duct surfaces, and in doing so resembles in malignant disease the multiple papillomata of a non-malignant disease (*see B, Part I*). (2) That having been established at one part of a duct, it may affect other parts of it, or other ducts. The latter point shows that I propose to suggest a genetic process in the spread of cancer, in addition to the 'infiltrating' and 'permeating' processes in the lymphatic

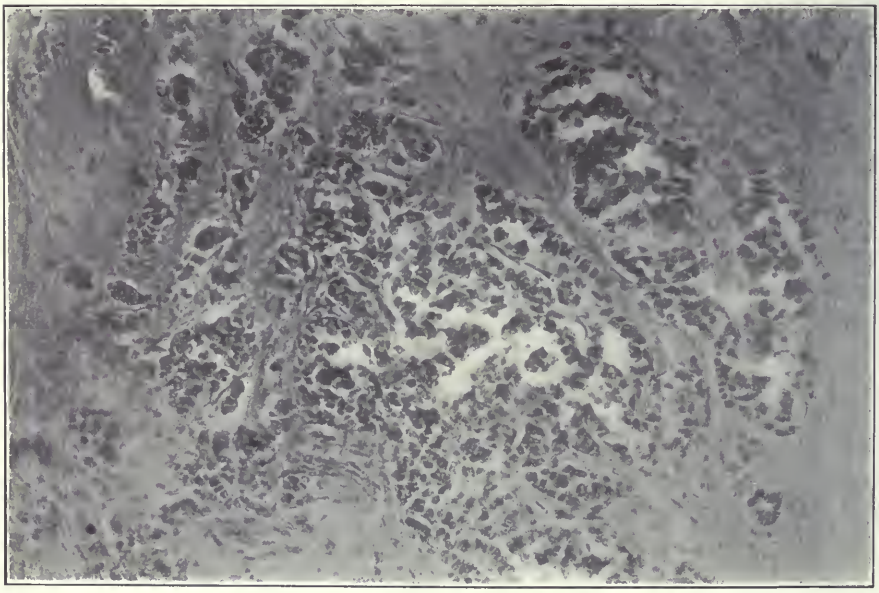

FIG. 211.—High-power photograph of the 'infiltrated' area seen in *Fig.* 209. The epithelial cells have lost their columnar shape, and are 'spheroidal', 'cuboidal', etc. There is no papillomatous formation in the area of infiltration.

system. The appearance contra-indicates the suggestion that all the cancer observable in these breasts started simultaneously.

I shall allude to appearances in the ducts that cannot be explained away by saying that under examination they are merely acting as pathways to accommodate an on-growing tumour, or that a portion of a pre-existing tumour has been grafted on a fresh site within the ducts, and that what is seen is merely a mass of shed and desquamated epithelial cells filling the ducts. I recognize that the strongest criticism that might be levelled against my interpretation of the facts would be that what I am about to describe is not cancer. Therefore it is necessary for me to state that metaplasia from normal into this disordered cell-growth can be observed in the ducts, that it 'infiltrates' the lymphatic system, and that it causes death. And whole sections of these breasts do not reveal any other possible primary lesion from which the spread in the lymphatic system could have emanated.

Figs. 213–217 show some of the whole sections of the breast from which I described the course of the cancer-containing duct on page 158 of my previous article. It will be understood that the distribution of the duct and some of its branches can be described only in the vertical plane. *Fig.* 218 is a diagram of this duct. It is also obvious that I am not in the least straining the imagination in assuming there are other branches, incapable of being schematized in this plane, which must be also cancer-containing. It is impossible to conceive that I have accidentally hit upon only that duct and its particular branches that are cancer-containing. I believe that the spaces filled with cancer at L_1, L_2, L_3, L_4, L_5, L_6, in *Fig.* 217, for example, are all cancer-bearing ducts cut more or less transversely. Take, for instance, three cysts of this series (*Fig.* 213, C_1, C_2, C_3); I am able to show that they belong to part of one duct. They all point to the correctness of my belief. The cancer contents of some of the cysts which are parts of the main branches of the duct have fallen out during the preparation of the sections; fortunately they have not been disturbed in the same parts in all the sections, hence it can be stated that all are cancer-containing. Take the cyst at *Fig.* 213, L_6, for example; here it is cancer-containing, but the growth has fallen out in the same cyst L_6 in *Fig.* 217. When one looks at *Fig.* 219, a photograph of a terminal distribution of a normal duct, one is appalled by the extent of epithelial surface that can be affected if the primary cancer process can be associated with duct distribution.

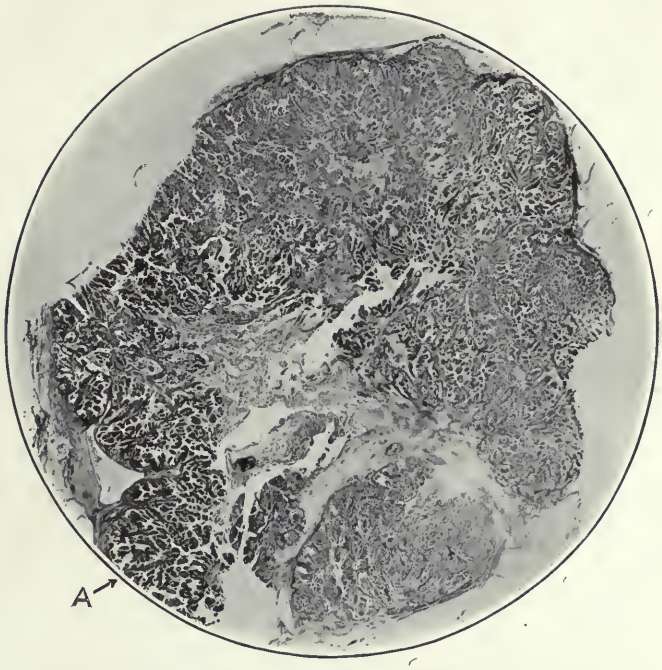

FIG. 212.—Whole section of breast which contains a duct cancer similar in general structure to that shown in *Fig.* 209. The papillomata are not lined in this tumour by typical columnar cells except occasionally—at A, for instance. In other parts they are lined by cells which are 'spheroidal' in shape or not quite columnar.

Figs. 213–217 are photographs of whole sections of a breast in which the left half is cancerous and the right half fairly normal, though a few small cysts can be observed at the periphery of some of the sections. To reproduce the whole series would be impossible.

FIG. 213.—Whole section of a breast. A, Nipple. Cancer occupies the left half of the breast. 'Infiltration' has occurred in centre. The right half is fairly normal. B marks a portion of growth in colloid degeneration; it occupies the termination of a duct, and is probably dilating its ampulla. This photograph is the first of the series which contains the cancer-bearing duct schematized in *Fig.* 218. It is desired that the cysts marked D, E, F, G, H, I, should be followed in this figure and in *Figs.* 214, 215, 216, and 217.

FIG. 214.—Later section to *Fig.* 213.

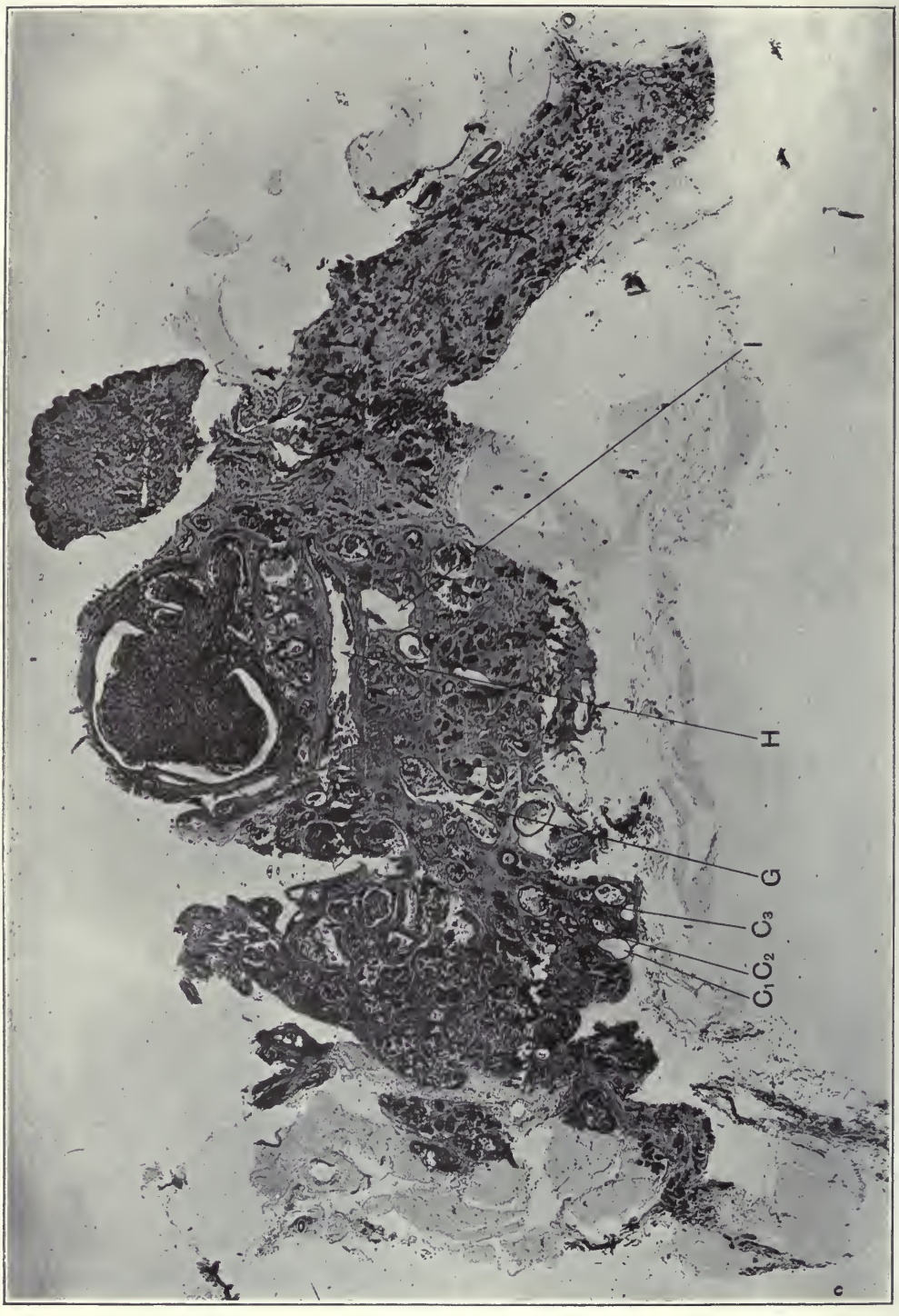

FIG. 215.—Later section to *Fig.* 214.

FIG. 216.—Later section to *Fig.* 215.

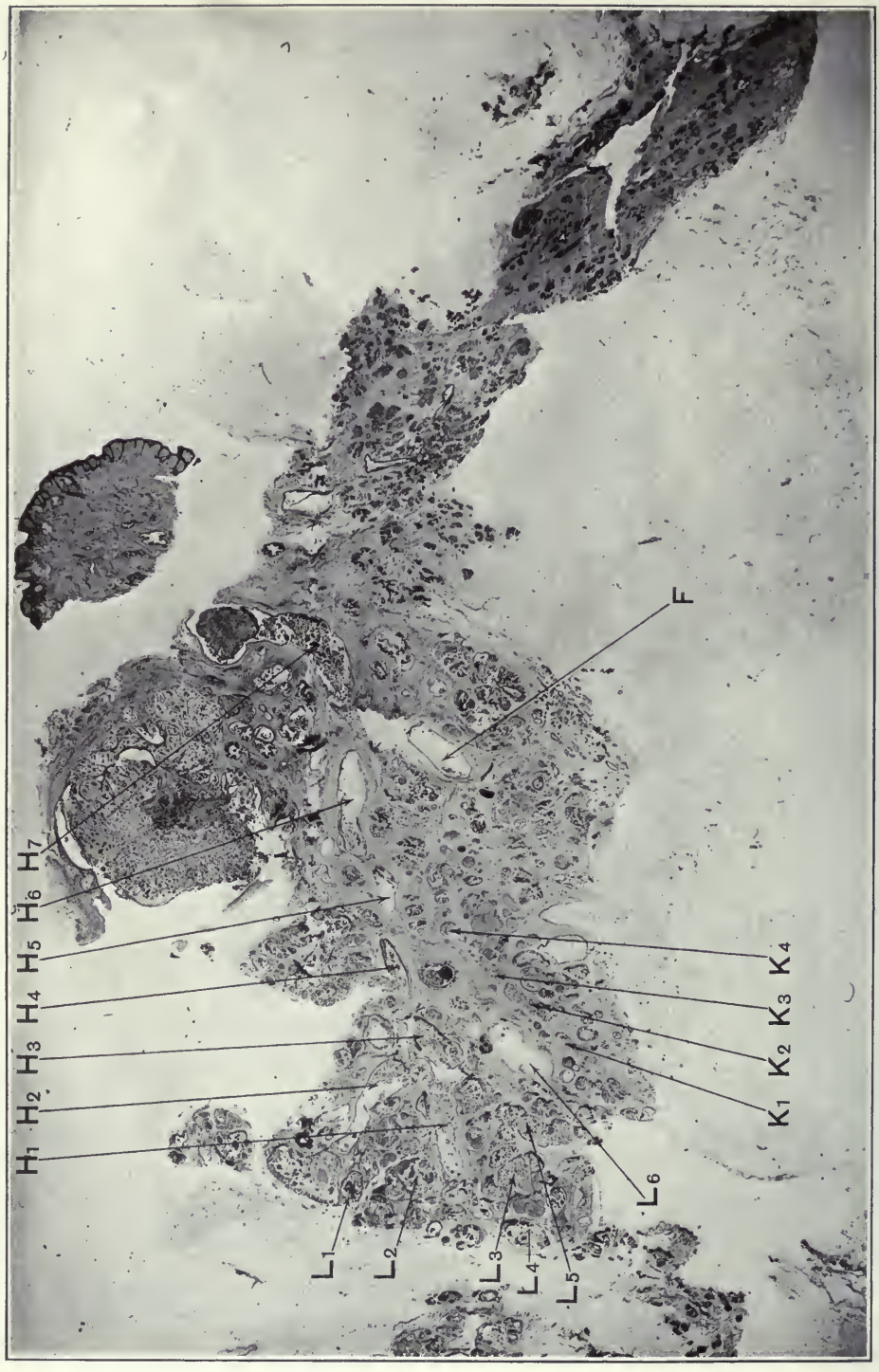

FIG. 217.—Later section to *Fig.* 216.

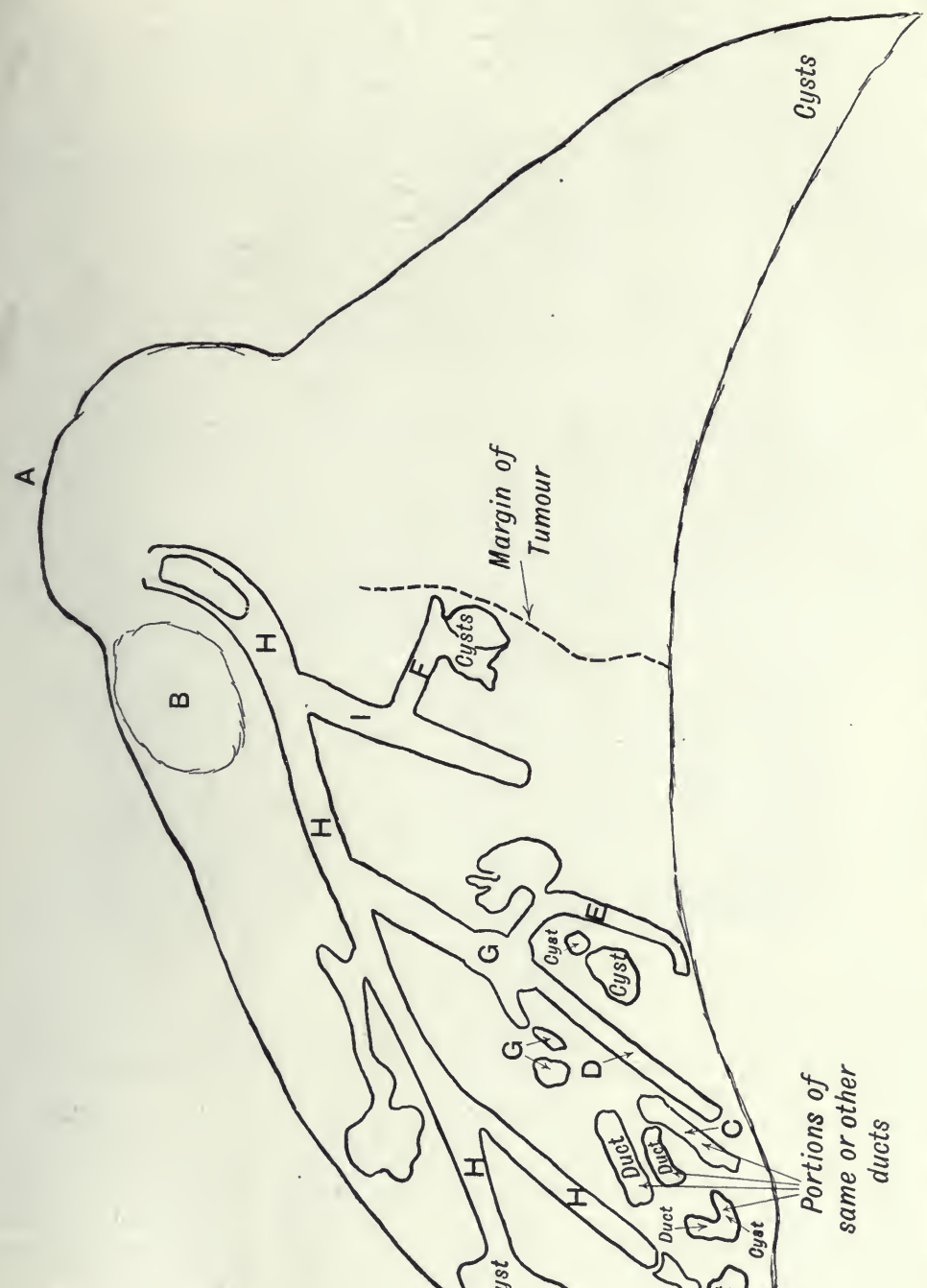

FIG. 218.—The cysts C, D, E, F, G, H, I, shown in *Figs.* 213–217, are here assembled in diagrammatic form, and represent that portion of the cancer-bearing duct which lies in the plane vertical to the nipple.

Now I will help the reader to trace for himself the duct schematized in *Fig.* 218. To save over-description of each photograph I have applied the same lettering to the same cysts. If he has time and inclination, the reader can then develop the course of this duct from the pictures. The cysts to observe are marked respectively D, E, F, G, H, I. In those pictures in which the letters do not appear, the main parts. being in different planes, have disappeared. They are assembled in *Fig.* 218.

Having described this duct, I would point out again that the spaces at L_1–L_6 in *Fig.* 217, also the cysts K_1–K_4 in the same figure, are all dilated ducts full of cancer, more or less in transverse section, which belong either to the branches of the duct I have schematized, or other ducts all of which occupy a different plane. In support of this conception I would ask the reader to imagine the branch of the duct E in *Fig.* 213 cut transversely, not longitudinally: it would exactly resemble those spaces at L_1–L_6 in *Fig.* 217.

I desire to draw particular attention to the cancer of the breast from which this cancer-containing duct is schematized in *Fig.* 218. The outstanding feature is this: In no part of the course of this cancer-containing duct and its branches does the contained

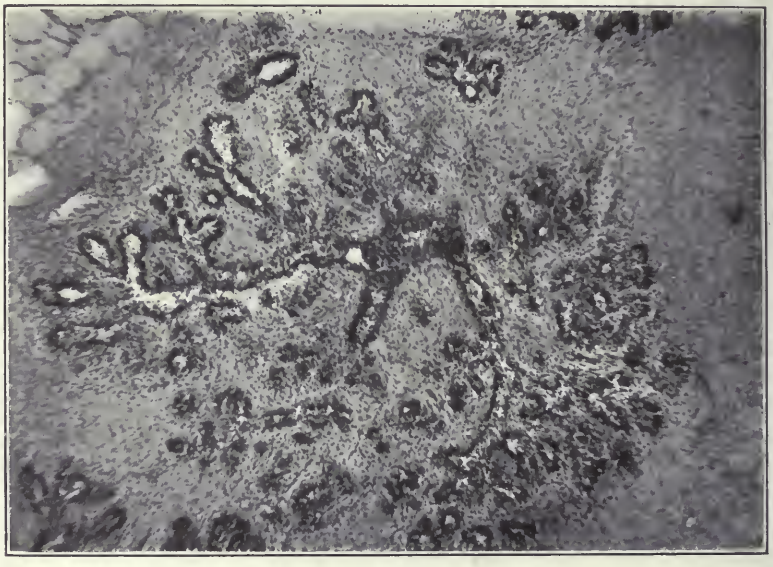

FIG. 219.—Duct distribution close to its termination.

malignant growth appear to be merely an on-growing tumour spreading in the ducts. Throughout the course of the duct and its branches the epithelial cells constituting the lining appear to be the victims of the primary cancer process. The cancer appears springing diffusely from the epithelial lining.

Now let the reader look again at *Fig.* 203. It is a photograph of the periphery of a breast. From the few serial sections I have of it I have traced lines which show that the cysts are parts of ducts. These ducts are full of growth actually springing from the walls of the ducts. The epithelial lining of the walls is itself malignant. This is no spread of tumour, but it is an extensive process affecting the epithelial cells of the duct walls. It is a metaplasia of the epithelial lining. I could discover no other lesion in any part of this breast from which the infiltration in the lymphatic system could have been derived. It is important to observe in this breast, and in the specimen sent to me by Mr. Sampson Handley, that the 'infiltration' starts and radiates from the terminal branches of the cancerous ducts. Here the walls of the ducts are not surrounded by dense fibrous tissue (*see Fig.* 219), and 'infiltration' must be easy.

It is interesting to draw attention to the whole section of the breast in *Fig.* 220. Two parts on opposite sides of the breast are affected with duct cancer. It is quite possible (in fact I have already suggested the opportunity) that serum containing living cancer cells might have escaped from the ducts communicating with the cancer at A, and,

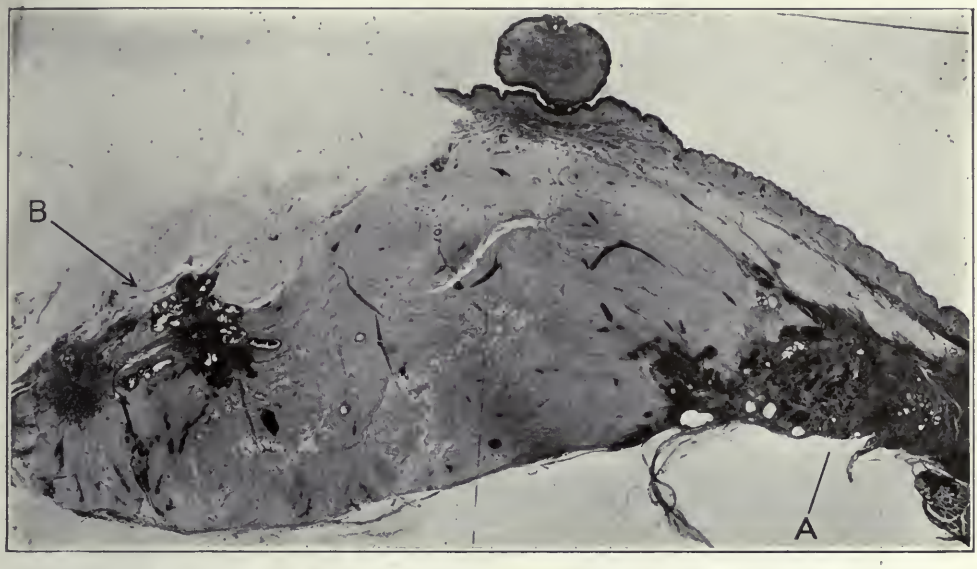

FIG. 220.—Whole section of breast. Cystic duct cancer at A, and another focus of same disease at B. The focus at A was that which attracted all the clinical attention. The focus at B was not discovered in a careful clinical examination.

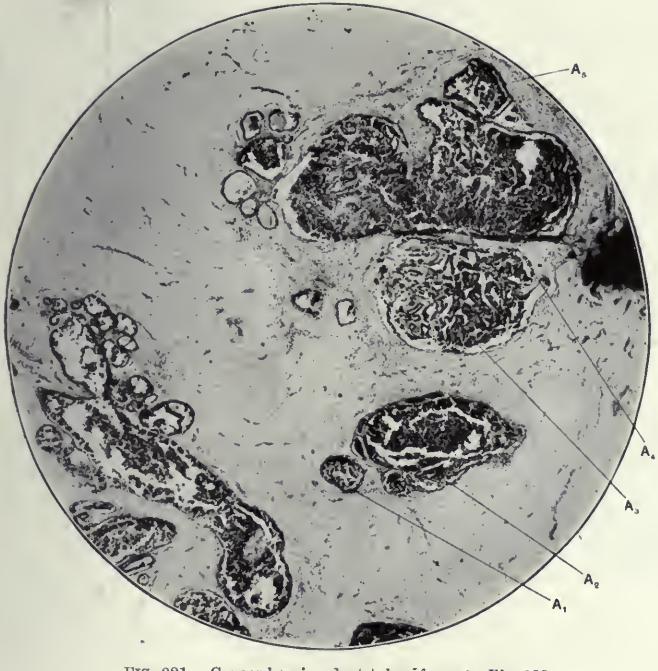

FIG. 221.—Cancer-bearing duct taken from A, *Fig.* 223. A_1–A_5, Cysts which are parts of one duct.

having reached the nipple, then entered the ducts communicating with the cancer at B, and, conducted by them, formed the grafted cancer at that part; but granting that possibility, it does not seem to be the explanation; the appearance compels one to think that there is a process in operation which is inducing primary cancer in duct cells of the part. Nor can it be that cancer has reached the position B by an extension in the lymphatic system; for it is not in the direction of lymphatic channels, and there is no indication of a lymphatic spread from A to B. There is at B a primary cancer change in the cells of the ducts. The only way in which the duct cancer at B could have been

induced by a problematical extension along the lymphatic system from A is that cancer, having thus reached the ducts at B, has burst into them, liberated the cause or part cause of cancer, and set up a primary cancer of the duct epithelium. From appearances I would prefer to argue that no graft, merely as such, had traversed the duct from the nipple, but rather that the cause or part cause of cancer had taken that course and set up cancer at B.

To the question—Are not the dilated ducts full of merely shed epithelium?—the answer is quite clear; it requires only a moment's observation of the ducts and the breast under this suspicion to convince one that the assumption would be quite contrary to facts. This is seen in *Fig.* 221, a photograph of a duct taken from A in *Fig.* 223. In

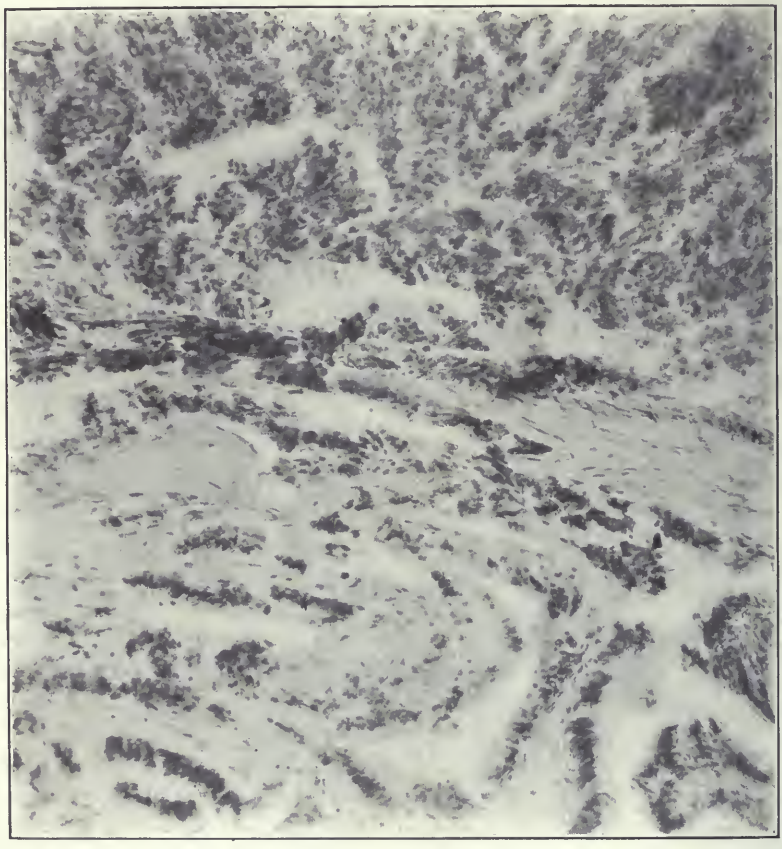

FIG. 222.—High-power photograph taken at B, *Fig.* 223. Malignant character of growth is to be observed.

these cysts I admit there is desquamated epithelium; so there is in most cancer tissue; there is in the primary focus at C, *Fig.* 223; but there is also in this duct A that which is more important, a papillomatous malignant growth, and many cysts around it are in an early stage of cystic cancer, in which actual metaplasia of the epithelium into malignant disease is occurring; this is also taking place in the ducts B_1, B_2, B_3 in *Fig.* 223.

It is the fact that ducts of this breast (and others) show the primary cancer process in different degrees of progression that compels me to assume that there is probably a gradual process by which primary cancer is being initiated elsewhere than at the more extensive and presumably primary focus.

The clinical and pathological observations of the disease in the woman seen in *Fig.*

224 are striking. The tumour that called the attention of this patient to her breast is seen above and outside the left nipple. Its situation, defined margin, comparatively recent appearance, and a history of a discharge of blood from the nipple, persuaded me

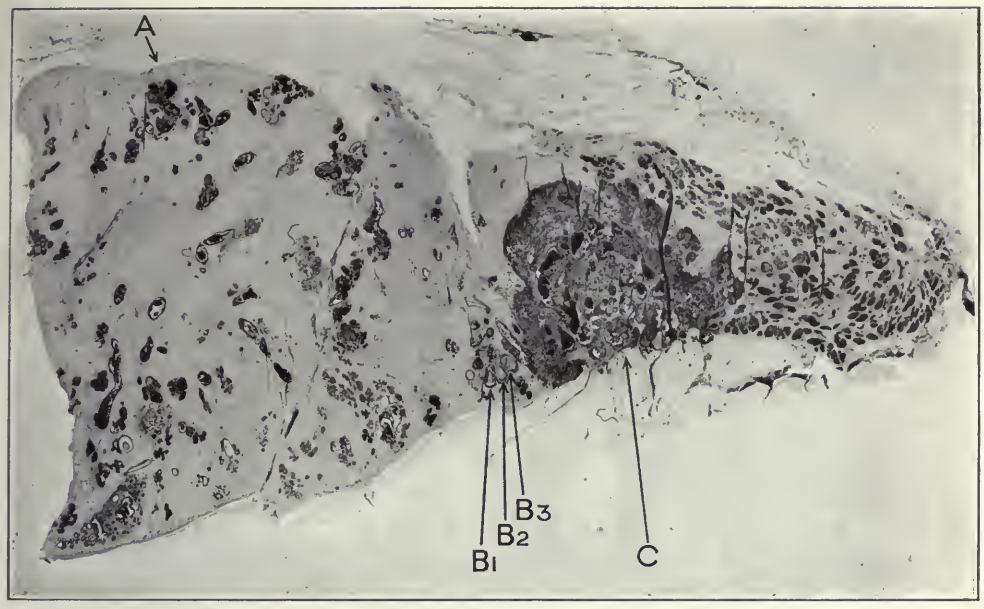

FIG. 223.—Duct-cystic cancer in a breast at C. Cancer-bearing cysts are seen at B_1, B_2, B_3, and cancer-bearing ducts in region of A. *See Fig.* 221, A_1–A_5.

to diagnose this tumour as a duct cancer. I could feel no glands in the axilla, though they were affected with cancer. The whole section of the breast was cut, and is seen in *Fig.* 225. On examination the tumour near the nipple was seen to be clearly only a spread in the lymphatic system from some other source. It was not connected with the nipple, which it merely pushed on one side. It struck me that this could not be the cause of the blood discharge from the nipple. I examined the ducts farther down in this section, and at C found a duct cut through transversely full of growth (*Fig.* 226), but nowhere else in the section could I find disease, except for the presence of a large duct adenoma seen on the right in *Fig.* 225. Fortunately the rest of the breast had been kept, and on digital examination I discovered part of it that appeared more dense than the rest. I determined to cut sections of this part. On

FIG. 224.—Photograph showing cancer of left breast. The tumour that attracted the patient's attention is situated above and outside the nipple. This tumour was merely the lymphatic 'infiltration' which has occurred from a deeper primary focus (at A) that was clinically undiscovered. There were glands implicated in the left axilla.

microscopical examination I found all the duct-cystic elements I described in my previous article, and also a spread in the lymphatic system outside them (*Fig.* 227). The latter corresponded in every way to the affected lymphatics in the tumour near the nipple.

The area affected in the deeper parts of this breast was an extensive one, affecting quite a fourth of the outer part of the breast. It was from this region and not from the tumour near the nipple that the blood from the nipple came. A large area of primary cancer existed in this breast that gave no clinical evidence of its presence. I am afraid that is characteristic of cancer that arises extensively in ducts. This and the breast in *Fig.* 221 demonstrate that comparatively large areas can be affected with cancer without any clinical sign of its existence being manifest.

I must draw the reader's attention again to the breast sent to me by Mr. Sampson Handley (*Fig.* 208). I have said before that it contained multiple benign papillomata in two ducts. Now I point out that branches of those two ducts contained cancer.

FIG. 225.—Photograph of whole section of breast seen in *Fig.* 224. The whole of the lymphatic infiltration at A has not been reached in this section. B is the nipple, which has been pushed on one side. The arrow C points to the situation in which was found a duct containing malignant growth (see *Fig.* 226 A). No other marked disease appeared in this section, except that on the right there is a large duct adenoma.

These branches were situated at three widely separated parts of the breast, one at the periphery on opposite sides, and the third at the periphery in the middle line. Each led directly into isolated foci of 'infiltration'. *Fig.* 228 is a photograph of the incriminating duct on the left periphery.

Before ending the description of these breasts, I must point out that the primary cancer in *Part II, A*, is more papillomatous than that in *Part II, B*, where it is more laciform in character. The diffusely distributed papillomata in *Part I, B*, are attached to the lining walls by more sessile stalks, and there is more branching. In fact they approach a condition, in many parts, of less benign appearance.

A paper of this kind can be made of practical value to the clinical observer if one is able to indicate therein a possibility of diagnosing a duct-cystic origin of the disease under his observation. This is indeed possible, but as a rule only when the disease has not run riot in the lymphatic system; it is that riotous spread that gives rise

to the attachment to the skin, producing the ominous 'puckering' which may obliterate all clinical and even microscopical evidence of its origin.

For the purpose of diagnosis I would call attention to the following points. A patient's idea of the time passed since she first noticed the lump in her breast is

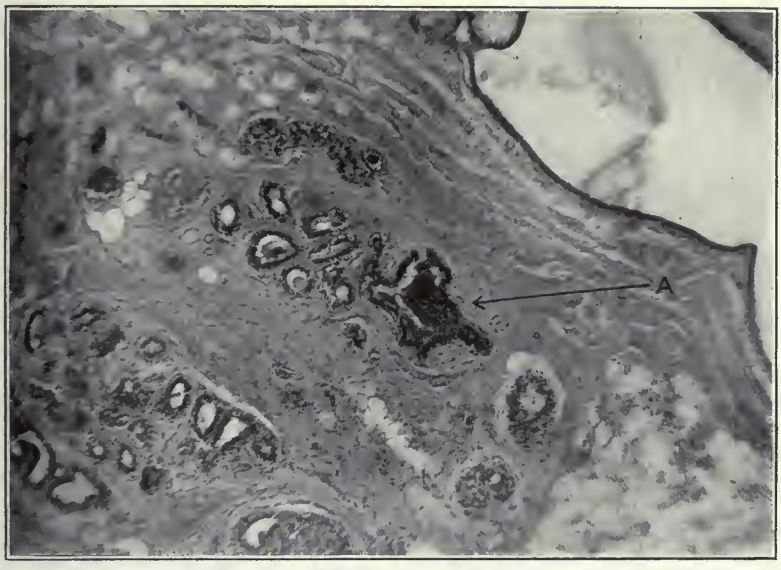

FIG. 226.—A high-power photograph of duct indicated at *Fig.* 225 C.

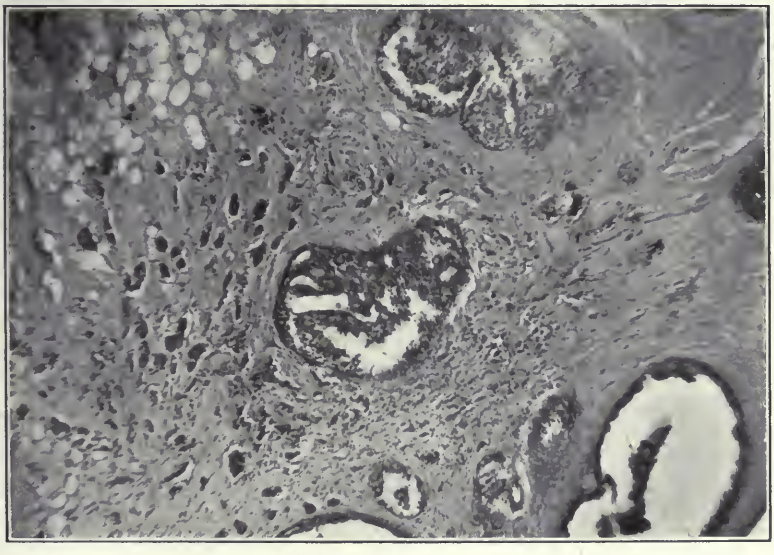

FIG. 227.—High-power photograph of cystic cancer process and 'infiltration' of lymphatic system from site shown at A, *Fig.* 224. The disease was extensive. It had not reached a stage to be discovered during a careful clinical examination. The cysts contained the 'laciform' structure described in my previous article.

often inaccurate. Her statement of a discharge of blood or clear fluid from the nipple is trustworthy. A large or a small solitary solid tumour not puckering the skin may be a duct adenoma, a sarcoma, or duct cancer; enlarged glands in the axilla would justify

a diagnosis of the last, and were it coupled with a discharge of blood or serum from the nipple this would more definitely confirm the diagnosis. The malignancy of this type varies enormously. It is always important, but in some cases it may be intensely malignant. Cancer in two breasts of the same patient, although not a common occurrence, is very well known to exist. In those patients where it has existed, and whose breasts I have been able to examine, the cancer has been of the duct-cystic type in both breasts. A very disheartening thing is the fact that breasts described under *B* in *Part II* can be in a state of advanced cancer with no definite clinical signs to indicate its presence (*see Figs.* 208, 224, 225, 226, 227).

If I might be allowed to state in what direction I would like to work had I the knowledge of biochemical processes, and the time and ability to carry them out, I would study the autolytic products of injured epithelial cells, to attempt to determine whether they could or could not, in whole or in part, influence ordered or disordered cell-multiplication.

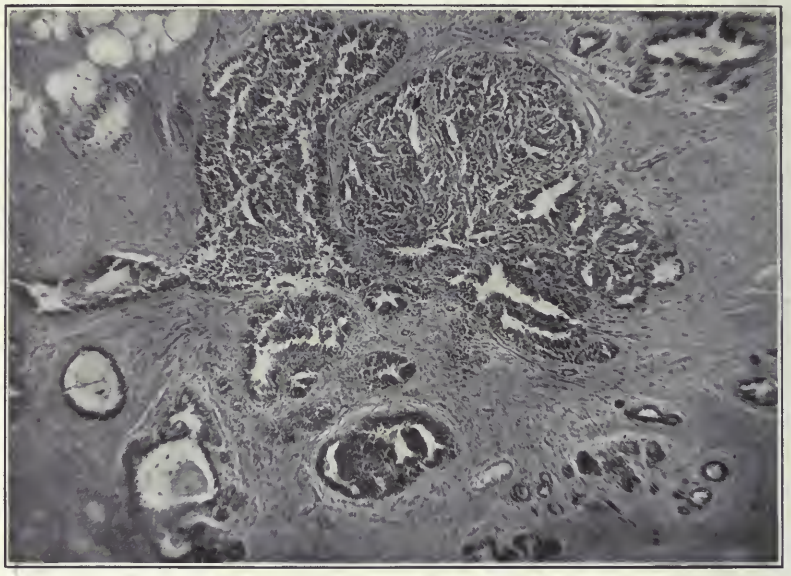

FIG. 228.—Duct on the left periphery of the breast shown in *Fig.* 208. It is one of the foci of primary duct cancer that arose in this breast.

It seems to me an investigation upon which great issues might depend. Many of these cancer-bearing ducts to which I have referred show no signs of a surrounding inflammatory cell fauna. Therefore I would bear in mind the possibility that irritation that was capable of inducing epithelial cells to proliferate might be too slight to induce a surrounding inflammatory affection.

The facts that young workers in tar suffer from warts, middle-aged workers in tar suffer from squamous epithelioma that falls out and cures itself, and that still older workers suffer and die from typical squamous epithelioma, point out that age must be taken into consideration in the investigation.

'Tar-workers' cancer' is an ideal experiment to study, and the late Mr. Harold Barnard's original observations on tar workers,* upon which the above statement is founded, are too important to be left out of consideration.

Again I have to thank Mr. J. E. Barnard for his skill in photographing my sections.

* *Polyclinic*, 1904, vol. viii.

THE SURGERY OF THE SPLEEN.*

By Sir BERKELEY MOYNIHAN, Leeds.

It was known to the ancients, and their knowledge has been confirmed in all later times, that the spleen is not essential to life. Aristotle wrote: "It is the position of the liver on the right side of the body that is the main cause for the formation of the spleen; the existence of which thus becomes to a certain extent a matter of necessity in all animals, though not of very stringent necessity". Erasistratus took the view that the spleen was wholly devoid of use. Galen spoke of it as an organ "full of mystery". In an old English translation by Holland of the *Natural History* of C. Pliny (23 to 79 A.D.) the following statement is found: "This member hath a proprietie by itself sometimes, to hinder a man's running: whereupon professed runners in the race that be troubled with the splene have a devise to burne and waste it with a hot yron. And no marveile: for why? They say that the splene may be taken out of the body by way of incision, and yet the creature live nevertheless: but if it be man or woman that is thus cut for the splene, he or she looseth their laughter by the means. For sure it is that intemperate laughers have always great splenes".

Shakespeare speaks of both these functions of the spleen:—

"Such fantastic tricks
As make the angels weep; who, with our spleens
Would all themselves laugh mortal."

And, again, Maria, in *Twelfth Night*, as she ridicules Malvolio before Sir Toby, says:—

Measure for Measure, II, ii, 121.

"If you desire the spleen and will laugh yourself into stitches, follow me."

Twelfth Night, III, ii, 72.

Of its effect upon the pace of a runner the Bastard speaks in *King John*:—

"I am scalded with my violent motion
And spleen of speed to see your Majesty."

King John, v, vii, 49.

In ancient literature the statement is made more than once that the giraffe, noted for a turn of high speed, is spleenless—an interesting example, of which evidences are still to be discovered in the literature of to-day, that statements lacking in truth, capable of verification or refutation, but never so tested, are slavishly copied by one author from another. In the middle ages, as Brogsitter has told us, the belief in the inhibitory effect of the spleen upon the pace of runners is found in Murer's *Belagerung von Babylon*:—

"Ich han mir lon dass milz Schnyden
Dass ich mag laufen wegt und veer."

It is interesting to note that, if records are to be trusted, the removal of the spleen from a human being preceded the removal, for experimental purposes, from animals. The following account of the first recorded case of splenectomy is given in *The Treasure of Human Life*, by Leonardo Fioravanti, Chapter 8. A translation has been kindly made for me by Mr. L. A. Sheppard, of the British Museum.

Treatment of a woman whose spleen I removed.—This same year (1549) in the aforementioned month of April, I was called to visit a Greek lady who lived near the garden of the

* The Bradshaw Lecture delivered before the Royal College of Surgeons, London, on Dec. 6, 1920.

Marquis of Terranuova. She was the wife of the Greek Captain Matio, who died afterwards in the year 1551, in the African War. This young woman, twenty-four years of age, had a very great enlargement of the spleen. It grew so large in her body that you could not conceive it larger. It caused both legs to be very badly ulcerated, and the poor woman could hardly live longer.

Having been visited by various doctors, she was told that if she wished to recover it was necessary to remove the spleen ; that it was an easy matter, without danger, and so on. So the poor woman, who had been the most beautiful lady of that town, and a great favourite, pondered whether she wished to die or recover, and began to beg the captain, her husband, to find someone who would remove her spleen. She begged so hard that the poor gentleman began to look for a doctor to perform such an operation, and while he was searching I was recommended to him. He came to see me at my house and took me to his home to see the lady. I saw her and talked to her, and cheered her as best I could. She asked me it I felt capable of removing her spleen. I said 'Yes' readily, although I had never before removed one. But since then, in Naples, I have removed another, as I shall describe when I come to that place.

So I promised to perform the operation, and having promised, every day she urged me to do so. But to tell the truth, although I had promised, I did not want to treat her for fear of making some blunder. But notwithstanding, I sent for a certain old man, of the kingdom of Naples, of a town called Palo. This old man, named Andriano Zaccarello, operated with the knife, removed cataracts and such things, and was much experienced in this profession. The old man soon came to my house, and I said to him, Dear Messer Andriano, a strange thing has come into the head of the wife of Captain Matio, the Greek—she wishes to have her spleen removed. I should like to know from you if it is a thing that could be done without danger ?' 'Yes', answered the old man, 'one can do it, because it is a thing that has been done many times in my life time'. 'Then do you feel capable of undertaking it ?' I asked. He replied that he would do it with me, but not otherwise, so we agreed to do it.

I went to see the lady, and made preparations with her and her husband, and having done so, went to the Justices, to give her up for dead, as is usually done.

And having permission, we went one morning to the lady's house. The good old man took a razor and cut the flesh above the spleen, which being cut, came out of the body. We went on separating it from the reticulum, and took it all out, and sewed up the flesh, leaving only a small opening. I dressed it with mixed oil of hypericum, incense powder, mastic, myrrh, and sarcocolla, and ordered her a drink of boiled water with ordinary honey, comfrey, betony, and holy-thistle, and every day I made her take a dose of theriac.

So I continued to relieve her in such a way that the poor woman in twenty-four days was cured and went to mass at the Madonna dei Miracoli near the Dogana, and was safe and sound. The spleen that was removed weighed 32 ounces. It was taken to the Loggia of the Merchants, and there remained three days, when all the town saw it, and the honour of such an experiment was given to me. Wherefore the people came to me as to an oracle ; and every day I debated with various people and learned many things in my subject, so that beyond the gain and experience I learned yet many secrets, and, to tell the truth, there is no better way of learning than by going about the world, for every day one sees new things and learns various important secrets.

The veracity of this description has been challenged more than once, chiefly because of the discrepancy between the alleged bulk of the tumour and the insignificant weight of the mass removed. Simon, chiefly for this reason, suggests that the tumour was an ovarian cyst from which much fluid had leaked between the time of removal and the time of weighing. If the description is true, it is certain that earlier cases than this had occurred in the practice of Zaccarello. Baillon* very briefly mentions the successful removal of the spleen in the year 1578 by an operator whose name is not given. Rousset described, in 1581, the successful removal by Viard, on two occasions, of a spleen which protruded through a wound on the left side. Two similar cases are recorded in the 17th century.

Observatio CXCV.—Cruger, Daniel. *De exciso liene ex homine, sine noxa. Miscellanea curiosa sive ephemeridum medico-physicarum Germanicium Academiæ naturæ curiosorum.* Decuriæ ii, Annut. Lertini anni M.D.C.LXXXIV. Norinbergræ, 1684, p. 378.

A man named Scultetus, of Heniekhagen, was knocked down by a rustic, and severely wounded in the left side by him with a knife. The wound made by the knife caused the prolapse of a large portion of the spleen. The man subsequently vomited, and wallowed in his own blood, and was left without any assistance during the night. In the morning, at the request of the magistrate, Nicolaus Matthias, a surgeon of Colberg, arrived, and found the unhappy man immersed in blood and the swollen spleen protruding from his body. All who were present, with the priest, saw the spleen, and were astonished at seeing so large a viscus protruding from the wound. By the aid of milk and herbs of a nature suitable for fermentation, the surgeon proceeded to tend the wound, and about sundown had the patient transferred to Colberg. On the following day a physician

* *Opera Omnia Med.*, i, 183.

was called into consultation, and the surgeon showed him the swollen and protruding spleen, and inquired of him whether he should excise it. The physician, who said the authorities had taught that no one could live without the spleen, was averse to this being done ; the blood flowing from the organs within the abdomen in large amounts would be without a proper passage for or method of exit. The surgeon, on the contrary, because the spleen was protruding considerably through the wound, said that he could not see that it was possible to replace the spleen in its proper position in the body, and that he considered it would be better that it should be removed. The patient consented to this ; he turned in this critical moment of impending death, and said that he was prepared to suffer everything patiently. The surgeon then ligatured the protruding portion of the spleen with a silk cord and withdrew the entire viscus from the cavity of the body. Next, that portion where it was adherent to the body he constricted with a cord, and on the third day afterwards he resected the whole spleen, and checked the abundant hæmorrhage with styptic powder. By the employment of suitable medicaments he restored the patient to health within the space of three weeks, although there remained in the wound a small swelling resembling a hazel nut, because at that place the vessels were adherent to the divided tissues. To this day the man lives happily with his wife, not deprived of offspring, and carries on his ordinary occupation.

The following is the testimony of an eye witness :—

I declare that I have seen with my eyes the spleen of a young man, age 23, projecting from a wound in the left side ; that the spleen was of the usual size, and that it was detached from all its connections ; I have also felt and touched the spleen with my hands.

That on the third day after the receipt of the wound it was excised by a surgeon summoned from the town, named Nicolaus Matthias. I know, because the same surgeon held a conference with me, and brought the same spleen recently excised. The burgomaster, Edw. Kundenreichen, and the pastor, Herm. Thom Hoppen, were also visited by the surgeon and were shown the spleen. Before it was excised the spleen hung out from the wound ; about the stomach it was torn from all its connections, also from the splenic artery and vein, and it resembled a rigid and gangrenous limb.

The injured man soon recovered from this and other wounds ; and was able to carry on his usual avocations ; and is in good health at the present time ; this I have observed with astonishment in company with those people with whom he is accustomed to mix.

(signed) Joh. Auenius.

Observatio CLXV.—Clarke, D. Timotheus. *De lienis resectione in homine vivo. Ibid.* p. 209. *Miscellanea curiosa medico-physica academiæ naturæ curiosorum, sive ephemeridum medico-physicarum* ; *Annus IV, V.* Francofurti et Lipsiæ, 1676, p. 208.

A butcher, named William Panier, living in the village of Wayford, near Crookhorne, in the County of Somerset, being greatly in debt, and feeling lest he should be arrested, was constrained to go into hiding. The constables were about to capture him, and becoming desperate, and in order to avoid them, he drove his butcher's knife into his abdomen on the left side, thus causing a great wound through which part of the omentum, and of the intestine, and also the spleen, protruded. The constables were horrified, and left the man for dead, as they believed. For three days the wound remained without a suture, but at last a surgeon was summoned. The surgeon replaced the intestines, and cut away part of the omentum, along with the spleen. The man rapidly recovered from the effects of the wound, and for the whole of the following year remained in good health and spirits. He soon afterwards emigrated to New England, where not long ago he was so far living a healthy life. Doubeny Turbervile, M.D., a man worthy of high credit, and a witness of the occurrence, renounced among our fellow-countrymen for his treatment of diseases of the eyes, has collaborated with me in communicating this observation.

The first experiments made upon the spleen were carried out in 1669, by Malpighi, who ligatured the splenic artery and vein in a dog. A subsequent operation showed that the spleen had undergone almost complete atrophy, and that the liver had enlarged. Malpighi's name is, of course, for ever associated with the lymphoid follicles of the spleen. In 1676 Clarke (*vide supra*) performed the first experimental splenectomy in a dog. The animal recovered, and the only subsequent change noticed in it was that it became much fatter. Morgagni describes a successful case of splenectomy in the dog, performed by Zambeccari, at Florence, in 1680. It is evident that he performed this operation himself quite frequently after this date, for he observes that, after studying the matter for five years, he found that the dogs underwent no special change in consequence of such an operation ; the dogs did not grow fatter, had no loss of fertility, and no change in their manners or disposition was noted.

In the nineteenth century experimental observations increased rapidly in number. In 1828 Schultz records that he had removed the spleen from 24 animals, 23 of whom survived the operation. After the operation the fertility of animals was reduced, there was a greater inclination and ability to run far, and a diminished secretion of bile. Czermak

also observed the lessened fertility of animals, and remarked upon the enlargement of the lymph-glands in the mesentery. In the year 1841 A. Bardeleben published the results of his experiments, which were directed towards the discovery of the functions of the spleen. They were the first well-considered and fully-recorded operations to be performed, and they have become classical. For the first time they showed with complete proof that animals could live and thrive after the removal of the spleen, and that certain changes, possibly compensatory in character, followed upon the loss of this organ. The changes noted were in the blood and the lymphatic glands. Vulpius, who followed in 1894, summarized his observations as follows :—

1. Extirpation of the spleen produces a transitory decrease in the number of red, and an increase in the number of white, blood-corpuscles.

2. The thyroid gland cannot vicariously assume the function of the spleen.

3. The lymphatic glands and the bone-marrow show an increased blood-forming activity after removal of the spleen.

4. The regeneration of the blood, after the loss of blood, is probably less rapid in individuals in whom splenectomy has been performed.

A great many observers confirmed these observations subsequently.

That the spleen is not essential to life is also shown by the fact that it is occasionally absent. Aristotle wrote : " The spleen is not invariably present ; and in those animals that have it, it is only present of necessity in the same sense as the excretions of the belly and of the bladder are necessary, that is, of being an inevitable concomitant ". Rokitansky and Ziegler in the middle of the nineteenth century asserted that the spleen was not always present, but neither gave any specific instance of its absence. At the close of the century Hodenpyl* found records of nine cases of alleged absence of this organ, and related a tenth case observed by himself. Two of the cases occurred in infants six weeks and one hour old respectively ; the remaining eight instances were in adults, the oldest being a woman, age 57, who had no unusual symptoms during her lifetime. The records of at least three of these are disputable. Indubitable cases of congenital absence of the spleen are related by Sternberg, Kohllass, and Riches.†

By the middle of the last century it was, therefore, conclusively established by experience which was beyond cavil that the spleen was an organ not necessarily present in normal individuals, that its removal, when successful, did not seriously impair the chances of life and of good health, and that after its removal certain changes assumed to be of a compensatory character followed in due course. The way was then prepared for the question of the deliberate removal of the spleen from man in conditions in which it was enlarged by disease. The first instance of such an operation is related by Quittenbaum, of Rostock, in 1826 (the father of ovariotomy in Germany), who, after a series of experiments in which the spleen was successfully removed from cats and dogs, undertook the removal of the organ from a human being. The patient, it is interesting to note in connection with recent developments of the surgery of the organ, was a woman suffering from cirrhosis of the liver and ascites. It was " the patient's urgent entreaty rather than the surgeon's judgement " which led to the performance of the operation in a woman so ill. She survived the operation only six hours.

Controversy in surgery may often tend to be coarsening, but we cannot gainsay its occasional advantages. It serves to challenge opinions which might too readily be accepted, to oppose reason to authority, to destroy prejudices, or to support a truth which otherwise might long pass unnoticed. In the year 1855 it raged round the question as to whether the operation of splenectomy could be justified. The story is told by Simon.‡ Küchler, of Darmstadt, had removed the spleen from a patient, age 36, who fourteen years before had suffered for nine months from malarial fever. The spleen on palpation was estimated to have a length of 13 inches and a breadth of 7 inches. Death four hours after the beginning of the operation was due to hæmorrhage from a branch of the splenic artery,

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* *Med. Record*, 1898, ii, 695. † *Jour. of Ment. Sci.*, 1914, lx, 630.
‡ *Die Extirpation der Milz* (Giessen, 1857).

which had either escaped ligature at the time of operation or from which the ligature had subsequently slipped. Post-mortem examination showed cirrhosis of the liver, and about 250 c.c. of serous fluid was present in the peritoneal cavity, with 625 grms. of coagulated blood. The matter was taken up by the Surgical Association of Hesse, represented by Simon, and a long and bitter controversy resulted. Simon's greater experience and authority seemed to prevail, and he decided that the operation was only justified in cases where a wound had been inflicted which threatened otherwise to be fatal. Küehler, in his defence, published a pamphlet, entitled, *Extirpation of a Tumour of the Spleen. Light upon the Question of Extirpation of the Spleen in Man, its Practicability and its Justification.** In this publication he gives details of the operation he performed, and draws a parallel with six previously recorded cases of splenectomy in human beings. In three of these cases the operation had been performed for hypertrophy or abscess, and in three for prolapse of the organ through an abdominal wound. Küchler sent this pamphlet to the Medical Faculty of the University of Dorpat with the request that they would communicate to him their opinion of the operation of splenectomy. Adelmann was appointed by the Faculty to draw up their report. He searched the earlier literature for examples of this operation, and formed an opinion favourable to Küehler's view. His report was published in *Deutsche Klinik* for 1856. Adelmann also inspired a thesis by Johannes Braun, of Warsaw, *Lienis in homine extirpatio*, published in 1857, in which the literal text of the earliest recorded cases was given. In this year, 1857, there appeared also the paper of Gustav Simon, which has been a storehouse of information upon the history of the operation for all subsequent writers. In this publication, the author, possessed of an extensive acquaintance with the literature dealing with the physiology, pathology, and surgery of the spleen, but deeply prejudiced by his controversy with Küehler, expressed the opinion that removal of the diseased spleen under any circumstances was an unwarrantable operation. Küehler's reply was to point out that "the conclusions of Simon are in themselves unreliable and illogical, and throw doubt upon incontrovertible facts". Adelmann† gives a full account of this discussion, and decides: "From such expressions we may conclude that there was personal friction between the two Darmstadt surgeons. In September, 1858, when I made the personal acquaintance of both of these colleagues in Karlsruhe, I endeavoured, unfortunately without success, to bring about a reconciliation between them".

The first splenectomy deliberately performed in England (the fifth in the history of the operation) for an enlargement of the organ, is related by Spencer Wells.‡ The patient was a married woman, 34 years of age, who was "evidently dying from a large spleen", and who had no other disease. The following is the account of the operation given by Spencer Wells:—

"I made an incision along the outer border of the left rectus abdominis which extended five inches above and two below the umbilicus. Two arteries were tied before the peritoneum was opened. In opening the peritoneum a rather large artery was cut across in a piece of omentum, which was loosely adherent between the surface of the spleen and the abdominal wall. The vessel was tied. The adhering portion of omentum was separated, and by putting in my hand and turning the lower edge of the spleen first through the opening, the whole of it was easily removed. The intestines were prevented from escaping by Dr. Wright, who kept the edges of the opening carefully together behind the spleen, which was held only by the vessels and the gastrosplenic omentum. I was beginning to twist the spleen round to bring the vessels into a sort of cord preparatory to applying a ligature, when the splenic vein, which was as large as a small finger, gave way, and blood ran freely from the spleen; but none was allowed to enter the abdomen, and I at once enclosed the vessels in a large clamp, and cut away the spleen. Before tying the vessels temporarily secured by the clamp, I passed eight silk sutures to keep the edges of the incision well together. The peritoneum was thus protected and the viscera retained while I was dealing with the vessels. These were tied in two bundles above the clamp, which was then loosened, and two arteries and a vein were also separately tied before it was finally removed. On taking it off, I found that a part of one end of the pancreas, as large as the end of a thumb, had been bruised by it. All the

* Darmstadt, 1855, Dietatall. † *Arch. f. klin. Chir.*, 1887, xxxvi, 442.
‡ *Med. Times and Gaz.*, 1866, i, 2.

ligatures, except those on vessels in the abdominal wall, were cut off close and returned with the included tissues. The sutures were then tied, and the abdomen was well supported by plaster, pads of lint, and a bandage."

The patient died of septicæmia 158 hours after the operation.

By this time the position of Spencer Wells in the surgical world was such that his authority was an absolute warrant for the performance of any abdominal operation. His sagacity, integrity, prudence combined with intrepidity, and technical skill were such as to command the respect of all men. And it was accordingly not very long before other operations involving the removal of the enlarged spleen were attempted. T. Bryant, of Guy's Hospital, performed the operation twice, in 1866 and in 1867, in cases of leucocythæmia. Both patients died rapidly from hæmorrhage, one fifteen minutes, the other one and a half hours, after operation. Koeberle, of Strasburg, performed a similar operation for a like condition in 1867; the patient died 'soon after', of hæmorrhage. Spencer Wells in 1873 and again in 1876 removed the spleen for this disease, and both patients died, one of peritonitis, one of hæmorrhage.

In the year 1882 H. Collier* reviewed the position of the operation of splenectomy, and gave a brief account of all the cases, 29 in number, submitted to operation up to that date. Of 13 operations performed for various conditions, 'wandering spleen', hydatid cysts, simple enlargement, 'ague cake', 8 were successful, the patients making perfect recoveries. Of 16 cases in which leucocythæmia was present, there was no instance in which the patient recovered even from the primary effects of the operation. Bryant's comment upon his two cases was as follows: "We have learnt two things from the cases related. Firstly, that enlargement of the spleen in leucocythæmia appears to be only a part of a general disease affecting the glandular system as a whole; and, secondly, that in splenotomy for such a disease there is a predisposition to hæmorrhage with which surgery is incompetent to deal. It can neither be foreseen by any amount of care, nor coped with by any amount of skill. Under these circumstances there is no shirking the conclusion that the operation is physiologically unsound and surgically unsafe, and, for leucocythæmia should not be performed".

From this date up to the last few years the operation was reserved for cases of injury, for spleens with a rotation of the pedicle, for cysts of the spleen, or for cases of enlargement of the organ due to causes which were not always discoverable. In the year 1898 Vanverts, in a Paris thesis, collected the records of 274 cases of splenectomy with 170 recoveries.

In the last few years splenectomy has been performed in certain of the anæmias associated with splenomegaly. The technique of the operation has been greatly improved, and the mortality in all classes of cases very considerably reduced.

Dr. W. J. Mayo has most kindly given me the records of the Mayo clinic up to September 20, 1920. They show better than any other record the modern position of the operation of splenectomy.

Splenectomies for Splenic Anæmia.

Total number of cases to Sept. 20, 1920	73
Total number of hospital deaths	9 = 12·3 per cent.

Out of a total of twenty-seven cases operated on 5 years or more ago, seventeen patients lived over 5 years; of these patients, sixteen are still living.

The results in splenic anæmia, generally speaking, have been good, but the operation is more difficult than in other conditions, and the mortality is considerable.

Splenectomies for Pernicious Anæmia.

Total number of cases to Sept. 20, 1920	53
Total number of hospital deaths	3 = 5·6 per cent.

Five patients living 4 to 5 years after operation. Eleven patients living 3 to 4 years after operation.

* *Lancet*, 1882, i, 219.

The fact that 22 per cent of patients have lived two and one-half times as long as the average, shows that in early cases of pernicious anæmia the operation is at least justifiable.

Splenectomies for Myelogenous Leukæmia.

Total number of cases to Sept. 20, 1920 26
Total number of hospital deaths .. .. 1 = 3·8 per cent.

One patient died 5 years and 4½ months after operation. Seven patients living 3 to 4 years after operation. Six of these are still living.

The results are poor in myelogenous leukæmia, but five patients are in good condition and two in fair condition after periods of time beyond the life-expectancy of these cases. The patients are at least relieved of the weight of the spleen, and in two instances supposed to be early cases of myelogenous leukæmia, not counted in this series, the patients have been cured, or at least they have lived a number of years following operation. The operation is not difficult after radium treatment, and in selected cases should be further considered.

Splenectomies for Hæmolytic Icterus.

Total number of cases to Sept. 20, 1920 32
Total number of hospital deaths .. .. 1 = 3·1 per cent.

One patient living over 9 years after operation.

The results in hæmolytic icterus have been excellent. Splenectomy is a real cure in a high percentage of cases.

Splenectomies for Septic Splenomegalias.

Total number of cases to Sept. 20, 1920 10
Total number of hospital deaths .. .. 2 = 20 per cent.

Splenectomy is undoubtedly indicated in some of these cases.

Diagnosis	No. of Cases	Hospital Deaths
Portal cirrhosis	9	4
Biliary cirrhosis	6	1
Lymphoma	3	0
Luetic splenomegalias	6	1
Lymphosarcoma	2	0
Gaucher's disease	4	1
Tuberculosis	4	0
Wandering spleen	2	0
Splenomegaly with eosinophilia ..	1	0
Splenomegaly with neutrophilia	1	1
Miscellaneous, questionable ..	11	2
	49	10

Thus the total number of cases is 243, with 26 hospital deaths.

ON THE FUNCTIONS OF THE SPLEEN.

(*See Fig.* 229.)

The cœliac axis, the first visceral branch of the abdominal aorta, supplies those organs, the stomach, the liver, and the pancreas, which are especially concerned in disorders of the spleen. The largest of its three branches is the splenic artery. Each branch of this artery within the spleen supplies a different compartment of the organ, and its main subdivisions each end rather abruptly in a small pencil of arterioles near the periphery of the organ. Close to its termination each of the subdivisions of the artery is enveloped by a small mass of lymphoid tissue, the so-called Malpighian body, in which the manufacture

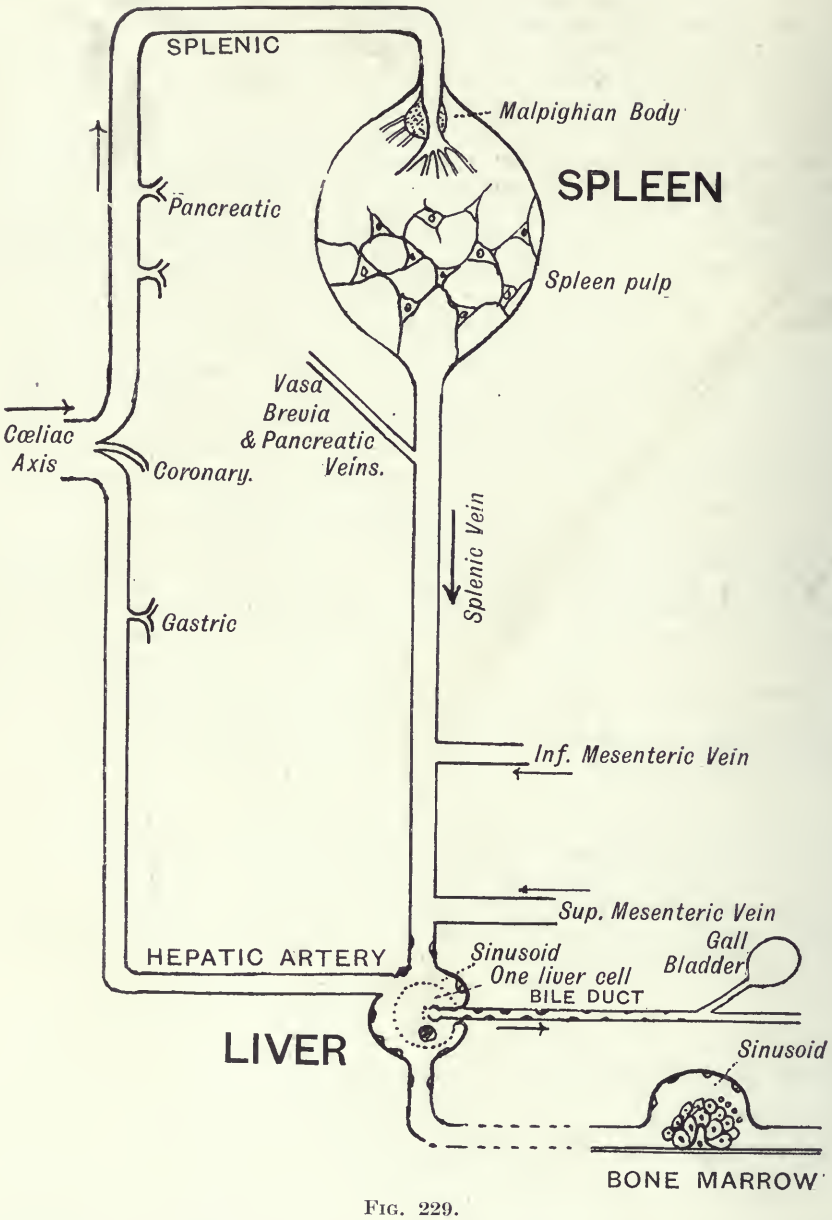

Fig. 229.

TO SHOW THE RELATIONS BETWEEN LIVER, SPLEEN AND BONE MARROW.

of lymphocytes takes place. This small mass of tissue is supplied by a coil of minute arteries springing at right angles from the main course of the vessel. In this way the large germinal cells of the follicle are provided with arterial blood, and give rise to successive generations of lymphoid cells until a colony of ordinary lymphocytes results. These lose their attachments and drift outwards into the surrounding splenic tissue.

The penicil of arterioles finally gives place to the spongework of which the spleen essentially consists. Taken broadly, it may be said that the spleen consists of a meshwork of delicate fibres which serve to retard the flow of the blood, and to allow its constituents to come into thorough contact with the specific cellular elements which are attached to the network in large numbers. These cells are similar to the cells lining the capillaries of all parts of the body. In the capillaries they are orderly in arrangement and definite in position, and they appear as the lining of complete tubes. In the spleen-tissue or spleen-pulp they are larger, they are disorderly, and they cease to form definite channels. Since it is admitted that the endothelial cells of capillaries are capable of phagocytosis, it is not difficult to see a close resemblance between them and the so-called reticular cells of the spleen. These latter cells, it is true, exhibit a certain sort of arrangement, since the blood runs more vigorously in some directions than in others, allowing a distinction to be made, on close examination, between blood-channels and pulp-cords. The latter are perhaps twice as broad as the more open channels which separate them, but cannot be regarded as solid tissue. The blood flows more slowly through them than through the adjoining channels. When, however, a pathological change occurs, it is not infrequent to find that the channels become relatively more distinct, and the pulp-cords more indefinite in character.

Various authors describe a number of types of cell as entering into the cellular composition of the pulp; but if we exclude the purely supporting cells (which provide the reticulum proper), it is possible to group all the others in one category—that of *modified endothelial cells*. There is an abundant literature dealing with the question of the specific pulp-cells of the spleen, from which it is possible to draw the following simple picture: that these modified endothelial cells which cling to the reticular meshwork are occupied in different ways at different times. Sometimes they remain stationary and gather up passing particles suitable as food; at other times they separate from the meshwork and wander among it—likewise for the purpose of engulfing solid particles (notably effete red blood-cells); at other times still they undergo proliferation. It is very probable that they remain stationary for this purpose, and produce daughter cells and granddaughter cells which adhere to one another for a time, but ultimately separate (either in the daughter or in the granddaughter stage), and remain in the spleen as, apparently, a special type of cell, or else pass away in the blood of the splenic veins.

It is especially important to notice that the blood in this meshwork is venous, since it is asserted that the processes of multiplication of the pulp-cells, and the varieties of cell which result therefrom, are particularly modified by the carbon-dioxide atmosphere in which they reside (Loele). The purely lymphatic cells of the Malpighian bodies, which lie in a medium richer in oxygen, give rise to a very different progeny.

The blood as it leaves the spleen carries with it some of these pulp-cells, or their descendants, but leaves behind it a certain number of red corpuscles and other solid particles. As it emerges by the splenic vein it immediately meets two streams of venous blood, one coming from the cardiac end of the stomach, and the other from the tail of the pancreas, facts no doubt of great physiological significance. Nearer the liver it meets successively a stream of blood from the descending colon, and the great mass of blood returning from the alimentary tract bearing with it the products of digestion, such as sugar and the amino-acids of protein, etc.

It is probable that a mingling of these various portions of blood occurs in the wide portal vein, but the degree to which this takes place is uncertain. There is evidence to show that, like the Rhone and the Arve, the two streams long remain separate parts of a great common stream. And the view is taken by many authorities, upon what appears reasonable evidence, that the larger part of the splenic blood goes to the left lobe of the

liver. Tested experimentally by injecting in the cadaver a continuous stream of red fluid through the splenic vein and a continuous stream of blue fluid by the superior mesenteric vein, the mingling of the two streams appears to be complete when the issue from the severed portal vein is watched. The stream of blood in the portal vein finally comes in contact with the liver tissue, whose cells exert upon it their metabolic activity. If we regard the matter as concerning a single liver-cell, the following events occur. The blood flowing from the free surface of the liver-cell becomes mixed with a small stream of blood derived from the hepatic artery, the next largest branch of the cœliac axis. Oxygenated and venous blood thus come in contact with the free surface of the liver-cell, which, if represented in a diagram, would appear to be protruding into a dilated vascular channel —a 'sinusoid'. All other surfaces of the latter are lined with endothelium, the cells being of conspicuous size, endowed with phagocytic powers, and known as Kupffer's star-cells. The liver-cells are now regarded as containing a network of intracellular canaliculi emptying into a small ampulla from which a minute duct issues. This, joining with other ducts similarly arising, forms at last a tiny bile-duct visible to the naked eye. Since the liver-cell forms bile out of the blood flowing in the portal vein, the ingredients of the bile must enter the liver-cell and appear within the minute canaliculi. If these substances enter, so also may other substances conveyed by the blood, and, by penetrating the liver-cell, finally obtain access to the bile-duct beyond. It is a fact that the liver-cell takes up other substances, which never pass into the bile-ducts, and stores them in the protoplasm without any risk of their emerging by that system of vessels. It is also known that the liver-cell is capable of discharging ferments into the blood-space around it, a fact which makes it reasonable to suppose that many changes can and do take place in the blood without the substances concerned entering directly into the liver-cell at any time.

In the spleen-pulp, the endothelial cells share one of the properties of all cells—that of making ferments. The blood may undergo definite change in chemical composition as it lingers among the meshes of the spleen. Then, before it enters the liver, it has become mixed with products from the stomach, and with ferment from the tail of the pancreas, where the islands of Langerhans are three times as numerous as elsewhere. Obviously some change must take place if and when the two become admixed ; and, indeed, the observations of Herzen and Bellamy* on the action of the splenic and gastric blood strongly indicate the existence of such changes. Finally, attention may again be drawn to the fact that this blood undergoes a still further change in composition by receiving the blood from the large intestine, and from the small intestine with its products of digestion, which necessarily include ferment substances absorbed with food.

The spleen has long been thought of as a blood-forming organ ; and during fœtal life it appears certainly to be concerned in the formation of red cells ; in consequence, dominant attention has been directed to the fact of its enlargement in many so-called diseases of the blood. It is therefore desirable to add to the picture so far drawn, details in reference to the chief of the blood-forming organs—namely, the bone-marrow. Arterial blood, entering the nutrient arteries, passes through the minute capillaries of the marrow of the long bones and enters into dilated cavities recalling those into which the liver-cells project. These also are called 'sinusoids'. The endothelial cells projecting into them are modified into large sustentacular cells, from which sprout the various cells described as concerned in the formation of red and white cells respectively. It has been said that the red cells form on such buds where they are bathed in arterial blood, while the white cells appear in those portions where the blood has become richer in carbon dioxide. As in the spleen-pulp, the daughter and granddaughter generations remain adherent to the sustentacular cell until they are ripe, after which they become loose and float away in the blood-stream.

The ground having been cleared by these very brief anatomical and physiological considerations, it now becomes possible to review the large amount of work which has

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* *Lancet*, 1900, ii, 371.

been done by many investigators in reference to the functions of the spleen, and perhaps to elucidate some of the difficulties of contradictory observations.

The lines of inquiry and research have been broadly as follows: (1) Study of the effect of splenectomy in man and animals upon the general health, upon the blood, and ultimately upon the various tissues; (2) Study of the action of extracts of the spleen, when administered in various ways; (3) Study of the action of splenic extracts on various phases of artificial digestion in the laboratory; (4) Biochemical investigations upon the spleen, upon the metabolic activities of the body, and upon the several secretions; (5) Microscopical studies of the spleen and other organs in case of diseases of the spleen, as well as in normal and splenectomized animals subjected to the action of various drugs; (6) Consideration of clinical cases in which the spleen was known to be diseased, any special phenomena being carefully observed in order to decide to what extent the spleen was to be held responsible for them. Of all these methods, the study of splenectomized animals has been most widely followed.

Even when allowance is made for the ultimate differences which are shown by the cases of splenectomy in man, due to the varying reasons for the performance of the operation, there remain certain *changes in the blood* which agree with those found in splenectomized animals. There is a temporary anæmia, gradually subsiding in approximately two months' time, and there is an increase in leucocytes, whose numbers return to the normal very slowly. An increase of the lymphocytes persists for about a year, and gives place to a moderate eosinophilia, which increases up to about 8 per cent during the third year. Apart from these laboratory discoveries there is no particular change to be noticed in the condition or in the health of the patient. It has been asserted that a certain degree of asthenia persists, and that the patient shows an increased liability to become infected with epidemic diseases, such as influenza. But in these respects there is no uniformity of evidence, doubtless owing to lack of knowledge of the normal resisting power of the patients, to differences of age, to the various diseases for which the operation may have been performed, and to the condition of health in other respects. When the extirpation has been for trauma, the general health of the patient may not have been previously impaired.

After the experimental removal of the organ from animals, certain additional observations have been made. The red cells have been found to become more resistant to hypotonic saline solutions, and the administration of drugs capable of causing hæmolysis has been found to cause jaundice less easily than before. Study of the animals after death has shown proliferation of the endothelial cells in the lymph-glands and in the liver, and a reddening of the bone-marrow has been disclosed.

Briefly stated, these are all the *salient* facts relative to the effects of splenectomy. They are meaningless unless the matter is carried further in order to force answers to certain definite questions which may now be asked.

1. *How much of the effect of splenectomy is due to the mere operation?* Pearce and his co-workers,* whose work is the most recent, and is distinguished throughout by great care and painstaking analysis, incline to attribute much to the operation. They point out that a certain amount of blood is lost with the spleen, and that the appearance of increased resistance of the red cells, and even of their susceptibility to hæmolytic drugs, may be related to the consecutive anæmia, or to the processes engaged in the repair of the anæmia. Banti has insisted that any such explanation is unsatisfactory, and asserts that the increased resistance persists long after the anæmia has passed away; and he further points out that in an animal rendered anæmic by appropriate drugs this change in the resistance of red cells does not occur.

2. *Does the spleen destroy red cells?* There is a general agreement that phagocytosis does go on in the spleen. The agents which carry on this work are the same kind of large mononuclear cells which are found in the sinuses of the lymph-glands. It has been found

**The Spleen and Anæmia*, Philadelphia, 1919.

that these cells are very much increased in numbers in the lymph-glands when drugs acting on the red cells are administered to a splenectomized animal. This suggests that these cells are carrying out vicariously the functions previously performed by the spleen—in other words, the spleen normally destroys red cells. Then, too, the occurrence in the spleen of phagocytes containing red cells in severe anæmias in man, can hardly have any other meaning than that the organ in these conditions fulfils that purpose.

3. *Does the spleen make a substance which weakens the red cells prior to their being engulfed by the phagocytes?* This action has been called 'the hæmocatatonistic function' (Bottazzi), and belief in its existence was based on the observation that the resistance of the red cells begins to increase at once after splenectomy, rising to a certain maximum, at which level it is maintained. But when it was found by other workers, including Pearce, that the same result will occur in the presence of the spleen, by treating an animal with a hæmolytic immune serum, it became evident that the problem is not as simple as Bottazzi assumed. It receives its true answer when the import of the following further questions is understood.

4. *Does the spleen pass on the blood-pigment for conversion into bile-pigment?* Removal of the spleen does not lead to absence of bile-formation, nor to the accumulation of blood-pigment in the blood. The explanation of these observations may be found in the fact that red cells may be taken up by phagocytes anywhere in the body and carried round to the liver. Material for the manufacture of bile-pigment is therefore still available, Pearce, evidently believing, I think, that the blood-pigment is *free* in the splenic blood, has endeavoured to discover what quantity of hæmoglobin must accumulate before it will overflow into the kidney or appear as bile in the urine. There appears to be a definite limit beyond which the colouring matter fails to be dealt with by the liver; and there is a limit to the amount of bile which can flow out of the liver-cell. If so much hæmoglobin is converted into bile-pigment that it cannot leave the bile-channels quickly enough, the excess of bile-pigment accumulates in the blood and jaundice appears. The amount of bile-pigment formed after splenectomy is at first approximately only one-half of that which is formed prior to the operation, and, as Martinotti and Barbacci have shown, this delay accounts for many of the phenomena arising in the course of experimental work upon hæmolytic poisons, and upon the short-circuiting of the splenic vein. All this work is based on the belief that hæmolysis in the body must be the same as hæmolysis in a test-tube, namely, a process of liberation of free hæmoglobin into the surrounding medium (that is, the blood-serum). But the splenic blood cannot be proved to contain free hæmoglobin, and the microscope shows that the red cells are not dissolved in the stream, but are consumed by phagocytic cells—facts of the greatest significance, which have been ignored or too little considered in this line of inquiry.

5. Similarly with reference to the question, *Does the spleen hæmolyse red cells by means of a ferment action?* Expressed in a more technical form, this means, Does the spleen manufacture a 'hæmolysin'? The literature on this point is very extensive, all of it showing how general is the belief that 'hæmolysis' in the body is comparable to a test-tube phenomenon. Yet all observers—Pearce included—have failed to find proof of this ferment action, which was first suggested as possible by Nolf. That the dissolution of red cells within the bodies of phagocytes takes place by an intracellular ferment action is obvious, but it is not in this sense that the question has been raised.

6. A further question often asked, as to *whether the spleen contributes an immune substance*, veils the same belief. The researches of immunology seek to establish the existence of chemical substances circulating as such in the blood-stream. Consequently, viewing these substances as secretions from cells, it is supposed that some of them are formed by the splenic cells, and would be likely to appear in more concentrated form in the splenic juice or in the blood of the splenic vein. In order to stimulate the cells of the spleen to greater activity, various substances have been used or devices adopted to bring about a greater destruction of the red corpuscles, in the hope that the spleen may be induced to secrete more of this immune substance. This accounts for the experiments devised to show the presence and purpose and mode of action of fatty acids and lipoids.

These substances dissolve the red corpuscles. Is it that the spleen prepares such reagents, or that the spleen needs the co-operation of the liver, since the liver is an acknowledged source of both these substances? Eppinger found that the total fats and cholesterin of the blood are increased after splenectomy, and King confirmed his work; but Pearce failed to substantiate it. Anitschkow, taking another side of the problem, sought to show that if the spleen makes a substance for the express purpose of dissolving the red cells, removal of the spleen should diminish the tendency to jaundice. As a matter of fact this does happen if the splenic vein is diverted into the inferior vena cava without removal of the spleen, and is, I think, to be explained by the longer route traversed by the splenic blood, which gives the liver more time to deal with the liberated blood-pigment, seeing that in the new arrangement this becomes distributed over the whole body, instead of being contained only in the portal vein.

Another argument in favour of there being such a function of the spleen is afforded by the fact that exposure of the spleen to *x* rays results in a diminished output of hæmolysin in the experiments on dogs (Hektoen). There are great difficulties in interpreting the experiments relative to this part of the subject, since the bone-marrow also must inevitably be influenced by the substances used to produce hæmolysis.

The whole subject assumes an entirely different aspect when it is discussed from the cellular side, as Sajous has fully done in his work on *Internal Secretions*. Hæmolysis in a normal animal is carried out by cells within cells; immunity-reactions are secured by the same means. These views are fully supported by the results of all the experiments to which reference has been made.

7. *Does the spleen secrete a substance capable of acting on the bone-marrow?* Danilewsky was the first to assert that this was the case, and others corroborate his view. The rapid anæmia after splenectomy, out of proportion to the loss of blood, suggests that some such substance has temporarily ceased to be formed. In one of Pearce's experiments a splenic extract administered to a dog dying from anæmia after splenectomy, saved its life. A single dose of splenic extract given intraperitoneally will induce a rise in the red cells and hæmoglobin content, in dogs who are not dangerously anæmic. The effect, it is interesting to note, is not produced when the splenic tissue is given by the mouth. Another argument in favour of this view, fortified by Pearce, is that regeneration of blood takes place much more slowly than usual when a splenectomized dog has been bled, or rendered anæmic in some other way.

As regards the part of the bone-marrow concerned with the formation of white cells, it has been suggested that there is normally a restraint of its activity through some substance secreted by the spleen. Increased activity of the spleen leads to increased formation of 'leucosplenins', and therefore, consecutively, to a diminution in the number of white cells in the blood. After splenectomy, there is leucocytosis due to the removal of this restraint. Undue restraint occurs, as Schmincke points out, in typhoid, syphilis, malaria, Banti's disease, Gaucher's disease, kala-azar, and Hanot's cirrhosis. When *x* rays are applied to the spleen, they stimulate the splenic cells, cause them to form more leucosplenins, and thus indirectly interfere with the action of the bone-marrow.

Pearce has decided that the relation between the spleen and bone-marrow is rather a matter of the changes which take place in the storage and utilization of the iron of the body than a specific hormone action. Bone-marrow becomes red after splenectomy because it begins to take on the function of storing iron. It is certain that animals suffer largely from loss of iron after this operation, and it is evident that red cells cannot be produced in the absence of iron. Hence the anæmia may have a perfectly simple explanation, making it unnecessary to introduce the notion of special ferment substances into a discussion of the pathology of this subject.

8. A final question: *Is the spleen concerned with the activation of digestive ferments?* Tarulli and Pascucci compared the digestive power of the gastric juice before, and some days or weeks after, extirpation of the spleen in dogs. They also studied the effect of administering watery infusions of 'engorged' spleens (that is, spleens removed from dogs in full digestion), observing at the same time whether the animals lost weight or not. The

result of their experiments is to show that the digestive power is constantly weakened after loss of the spleen during a period of two or three months. The use of a congested spleen-infusion eight hours before the meal restored the digestive power. Infusion of spleen removed in the intervals following active digestion failed to replace the loss of activity of the gastric juice of such dogs. The authors therefore conclude that the spleen provides a substance which causes the gastric glands to produce more pepsin. Hedin and Rowland, however, in 1901, found similar results with extracts of other organs.

The conspicuous feature of all this work—and the quantity of it is very considerable—is the attempt to study the organ almost entirely as a separate entity working in isolation. In future the most eager attention must be given to tracing up, and laying bare, every possible connection it may possess with other organs. The analogy with the work of the surgeon is interesting. In our earlier experience we were concerned with the clinical recognition and the operative treatment of diseases of one organ—the stomach, the duodenum, the gall-bladder, the intestine, or the appendix. We now realize that the diseases in these several organs are secondary, and that some common underlying cause for many of them may be present. Any operation upon one of these organs now involves not merely the examination of that one, but also the scrutiny, and possibly a further operation upon, any one or more of the others. Future experimental work must consider the spleen not as an organ whose functions are confined to its own activities, but as a member of a group of organs each concerned with, and influenced by, the activities of the others. And clinical work must regard the problems of its disease in the same manner. Microscopical examination of the organ, showing as it does exactly what are the tools with which the spleen works, or the tools that go to make up the organ itself, demonstrates very clearly that we have to deal with cell-structures which other blood-forming organs also possess and use; indeed, the capillaries of many parts of the body in general show similar structures.

Intimate connections with the spleen can be found in four important systems of the body: (1) *The hæmopoietic system;* (2) *The reticulo-endothelial system;* (3) *The digestive system;* (4) *The sympathico-endocrine system.* Each of these systems has a depôt, so to speak, in the spleen; but this organ also contains within itself a histological system into which the other four merge. Although the spleen constitutes a link in each one of these systems, they are all able to dispense with its service; and although the presence of the spleen is not by any means a matter of indifference to any of them, yet they are not permanently or irreparably affected by its loss.

1. **The Spleen as a Member of the Hæmopoietic System.**—The part played by the spleen in the formation of red blood-cells and neutrophile leucocytes in embryonic life is everywhere admitted. In adult life the connection is usually only demonstrable under the influence of infections and in the various forms of splenic enlargement, and rarely is there a reversion to the capacity of forming red cells. Leukæmia affords an instance of post-natal resumption of white-cell formation, though the process is, of course, enormously exaggerated. The mechanism of the change is the same in the infections as in leukæmia. The cells of the spleen-pulp become transformed into parent cells tending to give rise to neutrophile leucocytes as they originally did in the embryo. And the process is now the same as in ordinary bone-marrow, where endothelial cells, specially endowed, still give rise to these leucocytes.

A connection between the spleen and the bone-marrow has already been spoken of as dependent upon a hormone, elaborated by the spleen and expended in stimulating the bone-marrow; a hypothesis which explains certain facts. But, as has been suggested, the same facts can be explained more simply. The destruction of red cells by the spleen enables this organ to liberate effete iron in a form capable of reconstruction into a complex albuminous substance when it leaves the spleen to enter the liver. In this synthetic process the first step is checked by excision of the spleen; and sufficient iron to make the usual hourly complement of red cells is not then available for the bone-marrow. I think Krumbharr expresses this view when he asserts that the spleen furnishes a substance which is activated by the liver. But neither the substance, nor the activated products, are new

and additional; they are pre-existing substances, temporarily parted, and re-united in rejuvenated form on the distal side of the liver.

In the same way, the theory of Horbaczewski that the spleen-pulp secretes a substance normally restraining white-cell formation may be looked on as too superficial, and experimental evidence to support it is not at all conclusive.

2. **The Spleen as part of the Reticulo-Endothelial System.**—We owe the conception of this system of the body to Aschoff. It has evoked numerous investigations, and as time goes on it is regarded more and more as important, once again raising to supreme interest a sphere of action in the body the consideration of which has been neglected for nearly forty years.

Wherever the tissue surrounding capillaries is loose, the endothelial cells are found to be closely connected with the surrounding reticular cells. The endothelium and the perithelium form parts of a meshwork, and this again becomes connected with the reticular meshwork familiar in connective tissue. The spleen-pulp furnishes a very good picture of this arrangement, for the meshwork is made of reticular cells which can be traced continuously into the network formed of the fraying edges of the blood-vascular channels where they open out or, on the venous side, close up into the spongework of the organ.

In the liver, certain large cells, the star-cells of Kupffer, excited much speculation for many years. They are essentially phagocytic in function, and are really to be regarded as endothelial in nature. After splenectomy they undergo proliferation. In hæmolytic diseases they become filled with iron pigment. The endothelial cells of the lymphatic glands are also phagocytic, and undergo proliferation after splenectomy. They exactly resemble the corresponding cells in the spleen. Similarly, the bone-marrow provides a meshwork of cells exactly comparable to the cells of the splenic pulp, though characteristically active in their own special direction.

A complete histological system can therefore be easily traced in many important parts of the body. It is traceable, if less easily, as a generally distributing form of tissue, not specially noticed hitherto, yet performing one of the most important parts in the physiology of the body. It is rightly attracting increasing attention at the present time.

The nature of the spleen-pulp cell; the changes it may undergo in different diseases and under different forms of stimulus; its relations to the connective tissue of the organs; its chemical characters, and the powers of taking up certain 'vital' and other dyes—have all been carefully worked out during recent years, and give a satisfactory insight into the minute processes which collectively constitute the functions of the spleen. It is the phagocytic proclivities of these cells which account for the harbouring of micro-organisms in the spleen-pulp; and it is the great vitality of these organisms, even after ingestion, which accounts for the latency of many infections. The malarial parasites notoriously find a home here, from which they only emerge under provocation. The same is true of the pallid spirochæte. Whatever truth there may be in the view that cirrhosis of the liver is due to bacterial infection finds its explanation in the two phenomena of phagocytosis together with persistent vitality of the engulfed particles.

But these phenomena are not restricted to the spleen. When poisons capable of dissolving the red blood-cells are administered, the pigment is found scattered through all the organs in which this reticulo-endothelial system occurs, especially in the liver and in the lymphatic glands, less conspicuously (because less often examined?) in the bone-marrow. When Eppinger realized that the endothelial cells of the liver were identical in function with those in the spleen, he called them "the splenic tissue of the liver", and seemed to suggest that they are carried bodily from the spleen to the liver, whenever the former is overburdened or maimed. Lintwarew has shown that such a procedure actually occurs; and it is histologically evident that there is a permanent tissue as well. Aschoff's conception is, however, much more useful and suggestive.

The relation of the spleen to immunity is not merely a matter of its behaviour to the introduction of hæmolysins; its pulp-cells are concerned in the manufacture of the immune substances with which the body is furnished in the course of infections. Herein lies a

very important practical bearing in regarding the spleen as a member of the reticulo-endothelial system. The question is worthy of ample consideration.

In the early literature of splenic diseases the statement is not seldom found that the organ possesses, among its many functions, that of offering resistance to systemic infection. Its enlargement during some of the acute specific fevers, and in other conditions in which grave infections are present, was held to be an evidence that it was conspicuously active in defence. And experimental evidence, which was early sought, did at times appear to support this view; but such evidence was often conflicting. It was necessarily so; for no care appears to have been taken to choose healthy animals for experiment, and such results as were obtained were in part due, in all probability, to the existence in many of the animals of such diseases as would inevitably vitiate any conclusions. Of the early work, that of Pfeiffer and Marx* was the soundest. In investigating the formation of immune bodies in cholera, those authors found that the spleen and the medulla of the long bones contained a far larger proportion of these substances than any other part of the body; and this reservoir, so to speak, of defensive substances continued for many months, until the bactericidal properties of the blood were slowly brought up to the standard found in the spleen and the bones. They also found that immunity could be developed in an animal whose spleen had been removed some months before; but if the production of immunity was attempted and the spleen then at once removed, the immunity failed to develop. This suggests that the early removal of the spleen had afforded time for the vicarious functions possessed by the medulla of the long bones or other parts to have developed.

In 1891, Bardach† injected 25 normal dogs, and 25 dogs from whom the spleen had been removed, with 1 c.c. of an anthrax culture (rabbits are normally resistant to infection by anthrax). Of the 25 spleenless dogs, 19 died; of the 25 normal dogs, 5 died. Similar results were obtained when normal and spleenless dogs were immunized against anthrax before injection of the culture. The deaths in the spleenless dogs were more numerous.

Tizzoni and Cattani‡ injected cultures of the tetanus bacillus into three groups of rabbits: normal vaccinated, normal unvaccinated, and vaccinated spleenless. Animals in the first group resisted the inoculation; those in the last two groups succumbed. They were unable to render rabbits whose spleens had been removed immune against tetanus. It therefore appeared possible that the manufacture of a substance causing immunity was manufactured by the spleen. In their later work they seemed to realize, with Righi, that the removal of the spleen merely acts as any other major operation would, in reducing the general systemic resistance to infections. These results are not confirmed by some other experimenters, but, as a rule, too few animals were used by them to avoid the chance of error.

The most careful experiments hitherto conducted are those of Morris and Bullock.§ The following is a portion of their account:—

> Thirty-six apparently healthy young brindle rats, weighing from 50 to 100 grms. each, were splenectomized under ether anæsthesia. Great care was taken to guard against any operative complications, such as hæmorrhage or infection, and the subsequent autopsies showed that none had occurred. A similar number of control rats of like weight and breed were subjected to a laparotomy in which one testicle was removed. As the testicle is larger than the spleen, and the blood-vessels entering it are about equal in size to the splenic vessels, its transabdominal removal furnishes a very fair basis of comparison as to the effect of the operative trauma alone upon the subsequent health of the animals.
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> Both sets of animals were found to be active and thriving on the day following the operation. They were then exposed to chance laboratory contagion and kept under observation for several months. Whenever an animal in either series died, an animal of the other group was killed, and both were completely autopsied. Microscopical sections were made from all important organs, and cultures were taken from the heart's blood and from the peritoneal cavity or lung.

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* *Zeits. f. Hygiein.*, 1898, xxvii, 272.
† *Ann. de l'Inst. Pasteur*, 1891, iii, 571.
‡ *Centralb. f. Bakteriol.*, 1892, xi, 325.
§ *Ann. of Surg.*, 1919, lxx, 513.

It was then observed that the splenectomized animals almost invariably died before the controls, and that the death-rate among them was 80·5 per cent as compared with 38·9 per cent in the normal rats. Necropsy showed the following lesions: Congestion and parenchymatous degeneration of nearly all the important organs, varying from injection of the vessels and slight cloudy swelling to focal necroses or extensive disintegration of the parenchyma. If the animal had survived long enough for a reparative process to set in, there was replacement of the degenerated areas by newly-formed granulation tissue.

They conclude from these results that the spleenless rats were more prone to contract the prevalent rat plague, and that, having contracted it, they showed less resistance to its ravages. A second experiment with 72 rats confirmed these results, and showed that under ordinary laboratory conditions spleenless rats were far less resistant to a common infection than normal rats. The conclusion is therefore drawn that the spleen must in some way help to protect the animals against infection, since removal of another organ of equal size and weight, by a similar operative procedure, caused no impairment of the defensive mechanism.

In a further experiment two groups of 88 rats each were treated, the one by splenectomy, the other by abdominal castration, and were then injected subcutaneously with a sublethal dose of broth culture of the bacillus of rat plague. Of the castrated rats, 22·7 per cent died; of the spleenless rats, 87·5 per cent died.

The conclusions which flow from these most careful and exhaustive experiments are that the spleen affords great aid in resisting infective processes in rats, and that its removal robs the body of its resistance, or diminishes that resistance until such time at least as compensatory processes have had a chance to establish it once again in its original strength. Hektoen's experiments* appear to show that antibodies are produced in the spleen, lymphatic tissues, and bone-marrow.

So far as I am aware, no observations to support these conclusions have yet been made on man. But the evidence as to the defensive properties of the spleen which these experiments reveal is so strong that remembrance of this function of the spleen should always be borne in mind when the operation of splenectomy is under consideration.

3. **The Spleen as a Member of the Digestive System.**—Although it is well known that the spleen undergoes variations in volume during the day, becoming larger up to a period of about four hours after every meal, diminishing subsequently as a result of muscular action, there is much difference of opinion as to the purpose of these changes. Some regard the spleen as a reservoir for surplus blood, while others believe that the periodic enlargement is concerned with the digestive processes in the duodenum and small intestine. This last view is supported by two observations: (*a*) That the blood shows a leucocytosis during the period of digestion; and (*b*) That the blood of the splenic vein is richer in leucocytes than that of the artery.

We owe our early knowledge of the relationship between the leucocytes and digestion chiefly to Hoffmeister and Pohl. The great increase of lymphocytes in the intestinal mucous membrane during digestion was demonstrated by the former; and the relationship existing between this and the kind of food taken was indicated by the latter. The leucocytosis is most evident after a protein diet. Examination of the blood of the superior mesenteric artery shows a great increase of leucocytes during digestion, although the increase is due to the neutrophiles and not to lymphocytes. Subsequent observers have sought to belittle these observations. There are some who deny the existence of an increase of the blood-cells during digestion; others, who admit that such an increase does occur, consider it to be merely a part of a natural cyclic phenomenon having no direct relationship to any food ingested. It has been suggested that the increase may be in the nature of a protective mechanism, whose purpose is to ensure the detoxication of the products of protein digestion. The evidence on the whole seems to indicate that there is a definite relationship between the type of the dominant cell in the blood, and the quality of the food ingested. Neutrophile leucocytosis follows a meal of proteids and fats; lymphocytosis follows a meal rich in carbohydrates.

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* *Jour. of Infect. Dis.*, 1915, xvii, 415.

It may be that the spleen is concerned with the destruction of the surplus lymphocytes liberated during the process of digestion. If so, this would account for the undoubted enlargement of that organ which then occurs, and also for the lymphocytosis which follows splenectomy, the agent responsible for the destruction of these cells being then absent.

The relation of the spleen to the liver must be of the most intimate character, for every drop of splenic blood passes into and through this organ. The connection is well shown in regard to bile secretion, for it is everywhere admitted that the bile-pigment is derived from hæmoglobin, though the exact mechanism of the conversion is not understood. Assuming that the hæmoglobin must be carried to the liver in the free state, Banti and Furno searched for it in that form in the splenic vein. They claimed positive results, but Pearce does not confirm their observations. In the belief that the spleen contributes a substance which dissolves red cells, the blood of the splenic vein was then searched for evidence of 'fragile' red cells. Hammersten, Chalin and Charlet, and more recently Pearce, have all failed to find evidence of such a condition. This work, as well as the experiments of Pearce made to determine the 'threshold' for hæmoglobin, and the work of Anitschkow and many others, including Widal, would appear, as I have previously urged, to be quite irrelevant when once it is admitted that the hæmoglobin reaches the liver within the bodies of wandering cells, and not in the free state.

The fact that splenectomy in dogs lessens the liability to jaundice from the introduction of hæmolytic substances, has suggested that the spleen prepares a substance directly concerned in aiding the work of the liver, and the fact that the urobilin becomes less plentiful in the urine when a case of pernicious anæmia has been treated by splenectomy, points in the same direction. The urobilin is the evidence of increased hæmolytic activity in the portal blood. But the attempt to explain certain clinical phenomena of diseases of the spleen in terms of a 'hypersplenia' (Eppinger) or 'dysfunction of the spleen' (Hirschfeld) is due to a misconception either as to the purpose of the spleen or as to the significance of hæmolysis.

It is probable that in splenic anæmia the benefits of splenectomy are due to the liver receiving less work to accomplish in a given unit of time. The cirrhosis in the later stages results from the presence of the same toxic substances which excite the fibrosis of the spleen; the liver shuts off, and entombs within a fibrous wall, those substances with which it fails adequately to deal.

In those cases of splenic anæmia in which gall-stones are developed concurrently, the irritant traverses the liver-cells and enters into the bile, causing precipitation and encapsulation within the gall-bladder. It may also be that the composition of the bile itself is altered, the raw material supplied to the liver being short of some constituent, so that the product subsequently precipitates more readily around organisms within the gall-bladder.

The relation of the spleen to the pancreas is suggested by the anatomical features. The blood from the tail of the pancreas meets the splenic blood soon after leaving the organ. The classical work on this subject is that of Herzen, who sought to establish the existence of a 'trypsinogenic function' of the spleen. All the bearings of this work were ably set forth by Bellamy in 1900. It seems quite clear that the splenic blood is definitely different in composition according to the digestive period in which it is collected. The experiments devised to show this were exceptionally clear and convincing.

More recently, Sajous* emphasizes the importance of what he calls the 'splenopancreatic ferment' which comes into action between the spleen and liver, apparently detoxicating the blood which bears the food products. The albuminoid substances are converted into benign products in the liver circulation, and are passed on to the body at large in order to supply the tissues with a high percentage of phosphorus. This author, as I have said, strongly emphasizes the view that the functions of the spleen, in so far as they are to be revealed by a study of the blood of the splenic vein, will be found to be connected with the cellular and not with the fluid portions.

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* *Internal Secretions*, 8th ed., 1919, 531.

A relation of the spleen to the *small intestine* is shown by the fact that splenic extracts powerfully excite intestinal peristalsis. Such extracts are the basis of the preparation 'hormonal', which has been so much vaunted as a remedy for constipation, for lethargic appetites, and so forth.

The position of the spleen as part of the digestive system is also demonstrable in terms of the *chemical composition* of the organ, and of the phenomena of *purin metabolism*. Horbaczewski drew attention to the endothelial cells as the visible link between cellular changes and the formation of the purins shown by chemical analysis. Many eminent chemists have elucidated this part of the subject. The subject of *iron metabolism* has constituted an important chapter in the story of researches into the functions of the spleen. Asher principally, in addition to Schmey, Kruger, Bayer, and others, has shown by many experiments that variations in output of iron go with variations in the activity of the spleen. Splenectomy results in increased loss of iron from the body. The part played by the spleen in *fat metabolism* has been studied microchemically, and it seems clear that this organ provides a link in that very complicated process of body metabolism. Experiments which have been made to show such a connection have not succeeded in Pearce's hands.

4. **The Spleen as a part of the Sympathico-Endocrine System.**—The endocrine organs are those which produce an internal secretion. They belong to two main groups. In the first are those which now produce, or have at some time produced, an external secretion also. The pancreas is the best instance of this type; others are furnished by the testis and the thyroid. The second group contains those organs which do not yield an external secretion, and have never done so. The former exert their action through the circulation; the latter operate through the sympathetic nervous system.

The spleen has never yielded an external secretion; it is intimately connected with the blood-stream, and at the same time it has extensive connections with the sympathetic nervous system. The splenic sympathetic plexus forms a dense network round the splenic artery and its ramifications within the spleen. This plexus is closely connected with the solar plexus, and therefore comes into connection with the adrenal glands. Besides this, the spleen receives branches from the vagus nerve which supply the muscular tissue of the capsule and the trabeculæ. The French writers have named this system 'parasympathetic'; the American writers 'the autonomic-sympathico-endocrine complexus';* but before we can accept or make use of the term 'autonomic instability' to explain the action of certain phenomena in connection with the spleen, much more detail is required upon the whole subject.

When Cohen asserts that 'gall-duct crises' are started by changes in the splenic end of the vasomotor chain, he reminds us not to omit the action of the nervous system from our calculations, without affording us that adequate knowledge which we crave.

Extracts of the spleen, including the proprietary substance called 'hormonal', have been shown by Berlin to have a similar action to that of cholin upon vasomotor nerves. Stern and Rothlin have found that extracts of the spleen are also capable of acting specially on smooth muscle, even in very minute doses. The active agents in the extracts are called 'lienins', and it is suggested that the spleen is concerned with the preservation of the tonus of the stomach, and of the intestinal and other smooth muscles. The action is aided by the presence of adrenalin.

The relations between the spleen and thyroid have been discussed by Klinger, Asher, Streuli, and Luciani. Removal of the thyroid will not kill an animal if the spleen be removed first. Massenti and Coronadi found that the spleen shrinks after thyroidectomy. Streuli's work goes to suggest that the spleen 'balances' the thyroid.

Investigations have also been made to ascertain if there are any special relationships between the spleen and the thymus gland. According to Bayer, the activity of the thymus is reawakened after the spleen has been removed.

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* *Osler Memorial of* 1919 (S. S. Cohen).

THE PATHOLOGY OF SPLENIC DISEASES.

The pathological changes found in the spleen can best be grouped according to the affinities which exist between the causative agents and the various parts of the spleen-liver system which they directly affect.

1. In the first type the provocative agent excites either a mechanical effect, or a local lesion, of the exact kind produced in other organs. The results will be expressed by the formation of an abscess, by a deposit of tubercular nodules, by a metastatic new growth, and so forth.

2. In the second type, an organism lodges firmly in the pulp of the spleen without actually producing a gross lesion there. Like any irritant of chronic character, it induces changes in the reticulum akin to, or actually constituting, fibrosis. The best example of this condition is afforded by the chronic malarial spleen, wherein, according to modern experience, the parasites lie apparently inert for long periods, to appear from time to time in the general circulation as a consequence of some excitant, suspected or unknown. The tropical splenomegaly may be regarded as a similar example, since here also the parasites are found embedded in the splenic pulp. It is probable that many other chronic enlargements of the spleen may be regarded in the same light, and it seems not unlikely that spirochætal infections, whether syphilitic or of an unknown type, may account for many forms of fibrosis and of chronic diseases. The work of W. J. Mayo on cases of splenomegaly associated with incoercible manifestations of syphilis is referred to elsewhere.

3. The third type of process is that which is set in motion by toxic substances reaching the spleen from some nidus elsewhere in the body. Foci in the mucosa or submucosa of various parts of the alimentary canal, in which there is no frank suppuration, but merely a subacute inflammatory cell-infiltration of slight or moderate extent, are easily overlooked, especially in the examination of the dead body. In pernicious anæmia, of course, definite lesions of this kind have been discovered by means of a special technique, and have been considered by Hunter, who first recognized them, as the portal of entry of the causative infection.

Given the primary infected lesion, the course of the toxic substances continually poured out into the vascular system is identical (for a part of the circuit) with that of the blood through the spleen, liver, and bone-marrow. The toxic substances may be of various kinds, which may be named according to their action. They may remain in the blood-stream and act on the floating cells, or they may pick out certain tissues of the body. The selective power of streptococci (as shown by Rosenow) and of toxins is well recognized, and mutual affinity of soil and seed may also be present. There is nothing impossible, therefore, in conceiving that some toxins will affect the cells of the spleen-pulp exclusively, either causing degeneration in them, or stimulating them to increased activity. In either case the material which leaves the spleen may consist not only of the original toxin, but also of the products of degeneration or over-activity of the existing splenic cells. The poison contained in the blood leaving the spleen comes almost at once into contact with the blood from the stomach and the tail of the pancreas. In this way it may become altered enough to cease to have any deleterious action upon the cells next encountered, namely, the Kupffer star-cells and the other endothelial cells of the hepatic sinusoid, or the liver-cell itself. On the other hand, the toxic substance or substances may arrive at the liver unaltered, and there set up changes in the respective elements which go to make up the unit of liver-tissue. These changes are usually of a degenerative nature; but in some cases, owing to the toxins passing through the endothelium, reactive changes are excited in the fibre-cells enclosing the lobule. This is the beginning of cirrhosis.

Another series of changes results when the brunt of the action of the poisonous substances is borne by the hepatic cell itself. As occurs in other parts of the body, the passage through the cell may cause no damage, but may provoke changes in the parts beyond; in this case in the smallest beginning of the bile-channel. Here the bile itself may lose its fluidity, precipitates may form, which in the minute channels cause blockage and a mechanical biliary retention (with or without jaundice). Or it may

be that, without acting in any way upon the bile, the noxious substances first affect the endothelial lining of the bile-channels, and so set up some form of cholangitis.

In other cases, however, the liver-cell is itself affected, and a series of clinical phenomena dependent on failure of the hepatic function takes place. After that, the stereotyped secondary cirrhosis may occur.

Leaving the liver, the poisoned blood may pass through the heart and lungs without losing its toxic character, and may finally come in contact with the cells in the sinusoids of the bone-marrow, and interfere with their function, if there is any affinity between them. Where repression of function occurs, a certain type of anæmia results or a diminution in the number of the white cells which are being made there. Conversely, increase of white cells may occur, and leucocytosis form a conspicuous feature.

Sufficient evidence has now been accumulated to enable us to form some idea of the varieties of toxins which may enter or leave the spleen ; they are grouped according to their supposed actions ; as causing anæmia, hæmolysis, asthenia with muscular wasting, cirrhosis of the liver, fibrosis of the spleen, or proliferation of various cells capable of active increase (for instance in the germ centres of lymphoid follicles, or in the bone-marrow in myeloid leukæmia). Banti invoked the first three types to explain the disease which goes by his name.

1. The most active *poisons causing anæmia* ('anæmizing') are such as prevent the red cells from being formed. There is little doubt, however, that many substances are comprised in this group which produce anæmia rather by destroying the red cells or by rendering them vulnerable. In this case the phagocytes of the spleen-pulp become unduly active, and a complication is introduced, inasmuch as these pigment-laden cells carry their burden to the liver, disintegrate there, and overburden this organ, besides producing another and peculiar type of change—siderosis and proliferation of endothelial cells.

2. The *hæmolysing poisons* are important. They play the chief part in hæmolytic splenomegaly, and in some forms of severe anæmia, as well as in some special types of cirrhosis. Chevallier and Tourkine have been at much pains to insist on the dual character of the hæmolysing poisons, some of these having the property of actually destroying the red cells, while the others only cause them to become 'fragile'.

3. *Poisons which excite fibrosis* are very common. The process of fibrosis has been long assumed to be merely the last stage of an inflammatory process ; but there is evidence to show that fibrosis of the spleen may be a specific phenomenon, just as in the liver biliary cirrhosis is certainly the result of active and direct stimulation of the connective-tissue cells.

4. *The poisons which excite cell-proliferation* may concern the cells of the Malpighian bodies, as in lymphatic leukæmia and some kinds of Hodgkin's disease, or the cells of the spleen-pulp. In the latter case several things may happen. The pulp-cells may assume the properties usually restricted to the cells of the bone-marrow concerned with the formation of white cells ; in these circumstances bone-marrow cells are produced. If this should occur in a slight degree it is only revealed by microscopic examination. Instances of this action are afforded by various acute specific fevers. If it occurs in a greater degree the enlargement of the so-called splenomedullary leukæmia is brought about. Sometimes the pulp-cells develop enormous numbers of cells of all kinds, and so produce a tissue of very complicated structure, as in lymphosarcoma or Hodgkin's disease.

THE CLINICAL AND ASSOCIATED PHENOMENA IN SPLENIC DISEASE.

The clinical and other phenomena which occur as evidences of splenic disease may now be discussed as a corollary to the various matters so far considered. The list of symptoms and signs likely to be encountered resolves itself into a short one when the mechanical results which follow upon a gross enlargement of the organ, or upon the obstruction to the portal circulation by a terminal cirrhosis of the liver, are omitted.

1. **Anæmia.**— Anæmia is caused by many diseases. In this connection it is only necessary to consider the type of anæmia which rightly directs the attention of the clinician to the spleen as its cause. The preceding discussion has briefly dealt with the subject

of hæmolysis. It may now be asserted that a disease of the spleen is to be suspected when there is any evidence that hæmolysis is associated with anæmia. What exactly is the full significance of the term 'hæmolysis'? It may be taken to indicate the occurrence in orderly succession of the following events: a destruction of the red cells, the accumulation of their remains in the spleen, the ingestion of these remnants by the phagocytic endothelial and reticular cells, and finally the transmission of these engorged cells to the liver, in whose 'sinusoids' they are disintegrated preparatory to the absorption of their particles by the stellate cells of that organ. Hæmolysis will be rendered an easier, and therefore a more frequent process, if any diminution occurs in the resistance offered by the red cells to their destruction. Such a change has been described by Chauffard, who speaks of a 'dystrophy' of the red cells, a condition in which their vulnerability is increased, and there is consequently a special 'fragility'. It has been asserted that the presence of a fragility of the red cells indicates that the seat of any disease in which it occurs is in the spleen; but there is evidence to controvert this opinion. Such a fragility might be due either to an early error in the formation of red cells by which there was an attenuation (through defective supply of the necessary material) of their lipoid component, or to the inimical effects of a substance produced by bacterial agencies in some lesion, perhaps quite inconspicuous, in the mucosa of the alimentary canal.

But every anæmia associated with disorders of the spleen is not characterized by hæmolysis. There is another important group of anæmias in which the initial disorder is either in the bone-marrow (and in the later changes in the spleen) or is dependent upon the same cause as that which affects the bone-marrow. In this class of case, the medulla being directly damaged, the process of formation of blood-cells is inhibited, or even in some cases arrested. In Hodgkin's disease, for example, the bone-marrow may become involved, and the part concerned in the formation of red cells then undergoes atrophy. In this instance there is from the onset some agent which injures the spleen and bone-marrow almost simultaneously. The train of symptoms which follows the anæmia may then become masked in those far more conspicuous features which present the clinical picture of the original disease.

When once the process of hæmolysis has developed to the stage described above, the further course of events will depend on the manner in which the liver-cells cope with their increased burden. On the one hand, the poison (which has destroyed the red cells) may pass through the liver-cells without affecting them; the extra load imposed upon them is borne without injury. On the other hand, the poison may actually injure the hepatic cells, so that the excess of blood-pigment is disposed of with a steadily increasing difficulty. Then, at last, under a continued strain, the inadequacy of the liver may become apparent, either clinically in the form of jaundice, or pathologically by reason of the appearance of urobilin in the urine. The great functional capacity of the liver-cell accounts for the gradual, insidious, and tardy onset of the symptoms connected with the involvement of the liver in such conditions.

It is interesting to find that the clinical phenomena due to a hæmolysis are absent in those diseases in which the liver-cell is equal to its work and does not suffer impairment. In the enlargement of Hodgkin's disease, of myeloid and lymphatic leukæmia, of sarcoma of the spleen, of lymphogranuloma, all the phenomena associated with hæmolysis are characteristically absent. But none the less anæmia develops. The reason is, no doubt, the following:—

With the exception of the leukæmias, where the energies of blood-formation become overwhelmingly directed to the formation of white cells instead of red, these various diseases of the spleen are associated with progressive fibrosis; there is consequently a gradual interference with the normal capacity of the endothelial cells to remove effete red cells. This entails a loss of iron to the body. The liver-cells do not receive sufficient iron in that form which is suitable for reconstruction in the next step of the cycle. Even if phagocytes in other parts of the body assume the function of red-cell destruction, they have not direct access to the liver, and cannot therefore supply this organ with sufficient speed or adequacy. It seems quite clear, from the experiments in connection with iron metabolism, that the

spleen is situated where it is in order to enable the iron-laden endothelial cells to have a free channel for their passage into the minute capillaries of the liver, through which they are too large to pass.

2. **Jaundice.**—When jaundice arises as the result of a toxic process in the spleen-liver system, two matters require consideration. These are the site of action of the poison, and the nature of the poison. In splenic anæmia there is no primary interference with the activity of the liver-cells; it is only when cirrhosis develops in the latest stage that the cells become affected, and then only in an indirect manner by compression from without, rather than from disorganization within the cell. In hæmolytic splenomegaly, on the other hand, the liver-cells from the first are either poisoned or burdened beyond their normal capacity for dealing with blood-pigment. The remarkable tendency to cholecystitis and cholelithiasis in this disease suggests the passage of toxic substances into the bile, acting, perhaps selectively, upon the mucosa of the gall-bladder.

Jaundice does not necessarily appear, even though the process of disposal of blood-pigment is inadequately performed. The absence of jaundice, that is to say, does not justify the opinion that in any particular patient the successive steps in the cycle of the metabolism of hæmoglobin which have been taken between the spleen and liver are normal. When the blood-pigment is broken down, it gives rise to two portions, one free from iron, the other containing iron. The former, undergoing purely intramolecular change, appears in the liver-cell as bilirubin, and passes out into the bile capillaries; the iron-containing portion makes its way back to the site of the manufacture of the red cells. In disease, this story becomes modified, either at the first stage or at the second. The division of the blood-pigment molecule may not take place; hæmatin is then formed, and gives rise (it is supposed) to one of two substances (maleic imide, maleic anhydride), either of which being *colourless* will escape observation in the liver-cell. Or, on the other hand, the iron-free substance formed from the blood-pigment molecule may not become converted into bilirubin, but into a hæmopyrrhol, which is also colourless. In this case also, bile-pigment fails to appear in the liver-cells (and in the bile in the gall-bladder?) and jaundice is not present.

These considerations provide a suggestive basis for the explanation of the anomalies which appear from time to time in reported cases of cirrhosis associated with splenomegaly.

It has been stated above that the liver-cells become affected when cirrhosis occurs. It is desirable here to emphasize the mechanism of the production of cirrhosis, for the story is hardly complete without some reference to the pancreas. If so much has been said about the inter-relations of the spleen and liver, and so little about the pancreas, it is because there is a wealth of positive information respecting the former. If the secretion from the tail of the pancreas (where the islands of Langerhans are most numerous) plays a necessary part in the intravascular changes which take place between the spleen and liver, attention would naturally be directed to a determination of the frequency with which interstitial pancreatitis, focal or diffuse, is associated with splenic disease. Unfortunately our information is slender and uncertain. The direct connection between pancreatic disease and hepatic cirrhosis is at present clear only in one form of cirrhosis, the so-called 'pigmentary cirrhosis'. It may be that the cirrhosis begins merely as a consequence of the disturbance initiated in the spleen. It is clear that the presence of iron which is not in a suitable condition for reconstruction in the liver, aided by the direct action of a poison (modified by passage both through the splenic endothelium and the endothelial cells of the liver sinusoids), may excite an overgrowth of the fibre cells outside the liver lobules. If it should do so, not only will there be cirrhosis of the Laennec type, but there will also be a special form of pigmentary deposit. A purely hæmolytic poison, that is to say, has modified the process of disposal of blood-pigment, in spite of its own modification by the splenic products into a cirrhogenic substance. It is certainly significant that in such cases the pancreas not seldom shows a widespread change.

3. **Petechial Hæmorrhages.**—These are occasionally seen in cases of splenic disease, in leukæmia, and in von Jaksch's disease. They always denote damage to the endothelial cells of the capillaries in various parts of the body by a particular form of poison, named 'endotheliotoxin', because its effects are known and obvious, and because there is no

adequate knowledge indicating its chemical constitution. The minute petechial hæmorrhages are scattered through many organs, appear on serous surfaces, and may occur on mucous surfaces, as in the nose and on the gums or in the kidneys. In these cases they almost certainly denote the channel of excretion of the poison by which they are caused. Such clinical phenomena, as is well known, sometimes accompany the circulation of certain septic organisms or of the toxins derived from them ; they here signify a special property of the leukæmia and allied poisons.

4. **Muscular Weakness.**—This may be associated with an actual wasting of the muscle, which partly accounts for the emaciation noticeable in advanced cases of leukæmia and of splenic anæmia. When we remember the intimate association between the spleen and endocrine system, the question arises as to the extent to which the phenomena of muscular weakness and asthenia are to be attributed to a direct action upon the adrenal or thyroid glands. The inter-relation of these endocrine glands with each other and with the glands possessed of external secretions is only now being revealed to us by the work of many observers.

5. **Pyrexia.**—Pyrexia as a feature of splenic disease has only recently attracted close attention. There is a tendency to ascribe fever appearing in the course of diseases, hitherto regarded as intrinsically apyrexial, to a secondary infection with septic organisms, especially when the temperature curve, as is frequently the case, is intermittent. In Hodgkin's disease pyrexia is almost constant, is indeed regarded by some clinicians as almost essential to a correct diagnosis. In pernicious anæmia pyrexia runs in waves spread over three, four, or more weeks, to be followed by apyrexial phases ; in leukæmia there are also pyrexial periods. The question is raised at once as to whether each of these diseases may be of microbic origin. In hæmolytic jaundice fever occurs periodically ; it is generally slight, and lasts for two or three days. In other cases it is severe, but of shorter duration ; the temperature rises abruptly, remains at its maximum a very brief period, and falls quickly. There is the characteristic 'steeple' chart of cholangitis. In such cases stones are often, but not always, present in the common bile-duct.

6. **Splenomegaly.**—When the spleen is recognized, by any method of clinical examination, as being enlarged, it is certain that it is at least twice the normal bulk. Any enlargement less than this, and often even this, cannot be discovered by palpation or by percussion. Perhaps, taking an average of all cases, the very largest spleen is to be found in Gaucher's disease, the next largest in leukæmia, and the next in malaria, though occasional instances are found in this last disease in subtropical countries which surpass all others. Then comes a series in which the spleen is large, but not excessively so, and, finally, there are cases in which the spleen is not enlarged at all. Thus, the spleen may be involved in Hodgkin's disease without being clinically enlarged ; it is not always enlarged in pernicious anæmia, and its enlargement then bears no discoverable relationship to the gravity of the case. These aspects of the subject are so well known that this symptom is only referred to for the sake of drawing attention to the fact that an absence of enlargement of the spleen does not relieve this organ from the suspicion of being the source of a patient's illness.

7. **Leucocytosis.**—The significance of this phenomenon lies in the fact that it affords an insight both into the nature of the agent at work, and into the state of those tissues which are concerned in the manufacture of the leucocytes. There are some toxic substances which expend their whole baneful power upon the circulating leucocytes ; others affect their formative tissues ; while a few may act upon both. The action exerted may be one of stimulation, so that leucocytosis results, or it may be one of inhibition, and result in leucopenia. In pernicious anæmia the poisonous action on the bone-marrow affects the white cells as well as the red, so that a very low white-cell count is the rule. In hæmolytic jaundice, on the other hand, the action on the bone-marrow is one of stimulation, and leads to an increased outpouring of leucocytes.

Where the poisonous substances act upon the pulp-tissue of the spleen, upon the endothelium of the liver sinusoids, and upon the whole reticulo-endothelial system, exciting the dormant cells to form myelocytes (myeloid metaplasia), stray myelocytes can be found in the blood-stream. This occurs in some forms of acute splenitis, occasionally in Hodgkin's

disease, notably in infantile splenic anæmia, and sometimes in pernicious anæmia. The same process occurs in massive fashion in leukæmia, where every part of the reticulo-endothelial system competes against the rest in the effort to produce and pour out these abnormal cells. The pulp-tissue of the spleen then appears almost as a replica of ordinary bone-marrow tissue, and the immature cells pass freely into the blood-stream. In virtue of the character of these cells, which, strictly speaking, are not leucocytes, such a phenomenon should not be described as an extreme leucocytosis.

It is therefore not sufficient in any case of leucocytosis to determine merely the presence or absence of an increase in the number of white cells. It is necessary also to ascertain which varieties of cells are represented in the increase, and to recall the significance of each specific increase. An increase of the neutrophiles indicates the presence of toxins of nucleoprotein form, or of the products of dissolution of albuminous substances. An increase of lymphocytes denotes activity of poisons of lipoid character, with whose destruction these cells are especially concerned. The large mononuclear leucocytes are increased when the particles of abnormal matter are large enough to be microscopically visible. When the eosinophiles are increased, it may be concluded that the poisonous substances have an affinity for the sympathetic nervous system, although the relation of these cells to the integrity of the nervous system is not the only one they possess. Poisons may accumulate in various tissues and set up local accumulations of these cells (as in Hodgkin's disease) and at the same time excite the bone-marrow, the spleen, and the lymph-glands to join in the over-production of these cells.

The tubercle bacillus and the spirochæte of syphilis are well known to secrete lipoid substances; the association of lymphocytosis with these diseases is to be expected. That stimulation of the lymphocyte formation occurs in pernicious anæmia, splenic anæmia, and Graves' disease indicates the direction of the inquiry to be made into the ultimate causation of these diseases.

8. **The Spleen and the Hæmorrhagic Diathesis.**—During recent years the suggestion has been made that the spleen may in some degree be concerned with the life-history of blood-platelets. In a patient suffering from purpura hæmorrhagica there is a decided diminution in the number of platelets, and the spleen is enlarged. After splenectomy the normal conditions are restored; in proportion as the number of platelets is increased, so the clinical symptoms disappear. Cases illustrating this experience are recorded by Schmidt,* Benecke† and Kaznelson.‡ The name 'splenogenic thrombolytic purpura' has been given to this condition, and a 'thrombocytolytic syndrome' is described. It is supposed that there is an increased destruction of platelets by the cells of the reticulo-endothelial system. If, however, the whole of this vast system is implicated, it is not easy to understand why extirpation of the spleen should cure the disease or relieve the patient of symptoms. Katsch§ has reported cases of thrombopenia where there is no purpura; and, conversely, cases of purpura where the number of platelets is not diminished.

9. **Urobilin in the Urine.**—Recent work shows that the presence of this substance in the urine is an indication of functional inadequacy of the liver cell, which is accompanied by some degree of obstruction in the minute extracellular bile canaliculi. A certain quantity of bile escapes through the ducts, undergoes the usual transformation into stercobilin in the intestine, re-enters the liver, but cannot find a free exit through the hepatic cells. The significance of this phenomenon is that there is an increased breakdown of red cells and hæmoglobin, and that there is a state of cirrhosis in the liver; the degree of disturbance of function is in proportion to the degree of 'fragility' of the red cells. Viewed in this light, the next step to be followed, after arriving at a conclusion that the spleen is diseased, is to determine the degree of damage to the liver, and instead of regarding cirrhosis as a collective term for many distinct morbid entities, to view all cirrhoses as representative of degrees of implication in the one morbid process.

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* *Wien. klin. Woch.*, 1918, 487, 959.
† *Therap. d. Gegenw.*, 1917, Dec.
‡ *Deut. med. Woch.*, 1918, 5.
§ *Münch. med. Woch.*, 1918, 33.

PERNICIOUS ANÆMIA. ADDISON'S ANÆMIA. IDIOPATHIC ANÆMIA.

(*See Fig.* 230.)

The literature of pernicious anæmia is inexhaustible. But bulk is no index of value. It is only within recent years—and especially since the work of W. Hunter, and of W. J. Mayo, Percy, and others—that some enlightenment has been thrown upon a difficult and complex problem.

The first case of idiopathic anæmia was recorded in 1822 by Combe, who applied this term to it. As Hunter says, the problem which this disease has presented throughout its whole history was never more clearly stated. Combe was recording "a well-marked instance of a very peculiar disease which has been altogether overlooked by any English author with whose writings I am acquainted. Unfortunately, however, such is the allowable diversity of opinion on most medical subjects, that it is very possible the following case (disease) may be viewed in different lights, and receive different appellations; and while some may be disposed to regard this anæmia as constituting a morbid state *sui generis*, others may consider the defect in red circulatory mass (so extreme that every organ in the body, with the exception of the spleen, was deprived of its red blood) as an accidental and occasional circumstance denoting some peculiar change in the assimilative powers, the primary stages of which we have been unable to detect. Doubtful myself which of the two opinions may be the most correct, I shall do little more than state correctly the phenomena of the case, and minutely, the appearances presented on dissection. One remark only I may at present offer—that if any train of symptoms may be allowed to constitute anæmia a generic disease, the following may be considered an example of it in its most idiopathic form".

This description of Combe's case apparently attracted no attention. In the year 1855 Addison, in his *Disease of the Suprarenal Capsules* (pp. 2, 3), gave an account of the disease which, in fullness of detail, accuracy of statement, and beauty of language, has never been surpassed. As a preface to his description of what we now called 'Addison's disease', he considered that it might not be without interest or unprofitable to give a brief narrative of a form of anæmia the cause of which was not discoverable. It was whilst seeking to throw some additional light on this form of anæmia that he stumbled upon curious facts which led to his discovery of the disease of the suprarenal capsules which now bears his name. His account is as follows:—

"For a long period I had from time to time met with a very remarkable form of general anæmia, occurring without any discoverable cause whatever; cases in which there had been no previous loss of blood, no exhausting diarrhœa, no chlorosis, no purpura, no renal, splenic miasmatic, glandular, strumous, or malignant disease. Accordingly, in speaking of this form of anæmia in clinical lecture, I, perhaps with little propriety, applied to it the term 'idiopathic' to distinguish it from cases in which there existed more or less evidence of some of the usual causes or concomitants of the anæmic state.

"The disease presented in every instance the same general character, pursued a similar course, and, with scarcely a single exception, was followed, after a variable period, by some fatal result. It occurs in both sexes, generally—but not exclusively—beyond the middle period of life, and so far as I at present know, chiefly in persons of a somewhat large and bulky frame, and with a strongly-marked tendency to the formation of fat. It makes its approach in so slow and insidious a manner that the patient can hardly fix a date to his earliest feeling of that languor which is shortly to become so extreme. The countenance gets pale, the whites of the eyes become pearly, the general frame flabby rather than wasted; the pulse perhaps large, but remarkably soft and compressible, and occasionally with a slight jerk, especially under the slightest excitement; there is an increasing indisposition to exertion, with an uncomfortable feeling of faintness or breathlessness on attempting it; the heart is readily made to palpitate; the whole surface of the body presents a blanched, smooth, and waxy appearance; the lips, gums, and tongue seem bloodless; the flabbiness of the solids increases; the appetite fails; extreme languor and faintness supervene, breathlessness and palpitations being produced by the

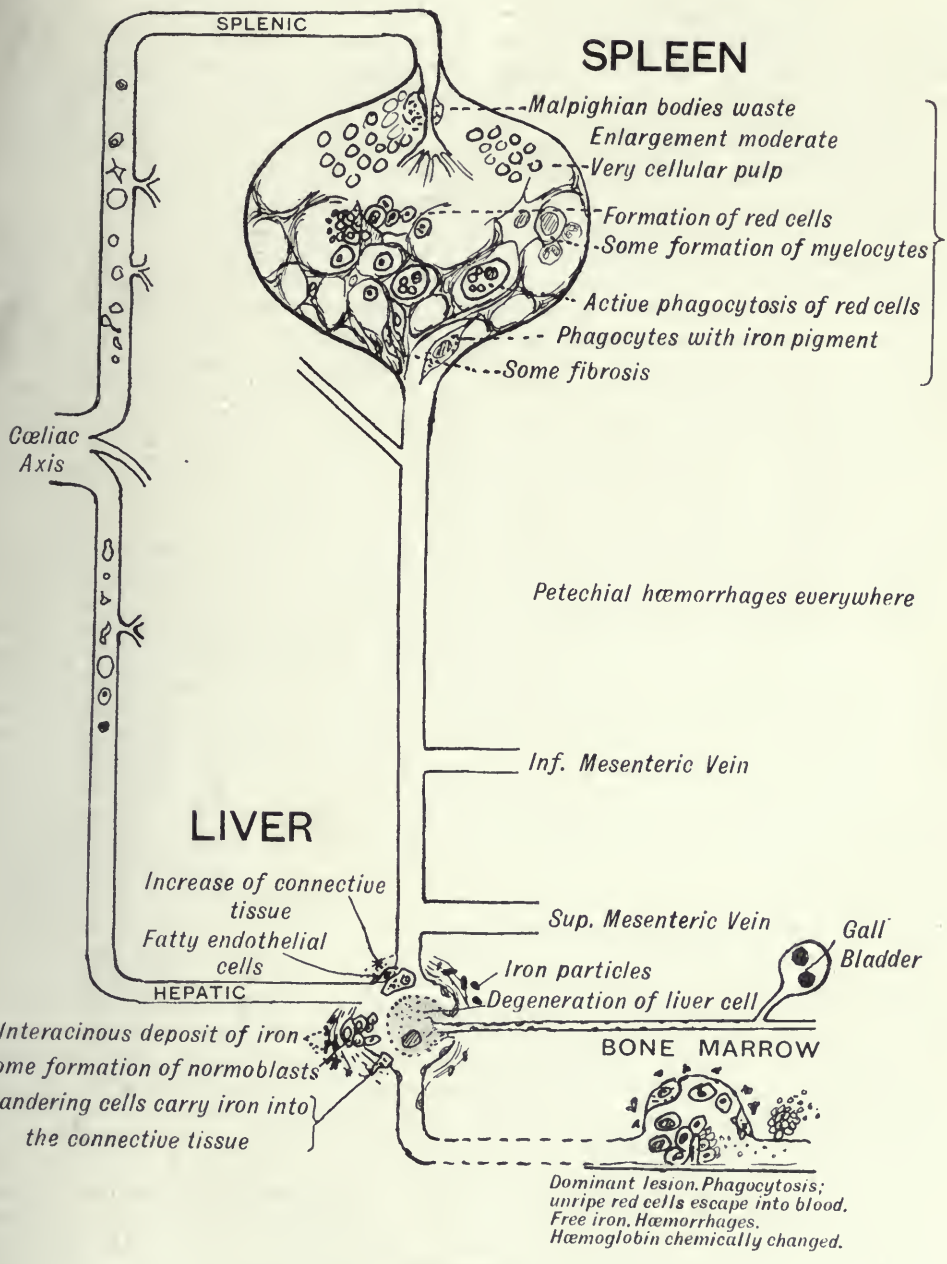

FIG. 230.

THE CHIEF CHANGES IN PERNICIOUS ANÆMIA.

most trifling exertion or emotion ; some slight œdema is probably perceived about the ankles ; the debility becomes extreme, the patient can no longer rise from his bed, the mind occasionally wanders, he falls into a prostrate and half-torpid state, and at length expires ; nevertheless, to the very last, and after a sickness of perhaps several months' duration, the bulkiness of the general frame and the amount of obesity often present a most striking contrast to the failure and exhaustion observable in every other respect.

"With perhaps a single exception, the disease, in my own experience, resisted all remedial efforts, and sooner or later terminated fatally. On examining the bodies of such patients after death, I have failed to discover any organic lesion that could properly or reasonably be assigned as an adequate cause of such serious consequences."

In the year 1871 Biermer described cases of this disease, apparently believing that it had not been observed by earlier writers. His claim to be the first to recognize the disease excited the wonder of the physicians in this country, especially those on the staff of Guy's Hospital. His writing, however, undoubtedly stimulated interest in the subject, and popularized the knowledge then possessed with regard to it. He gave to it the name 'progressive pernicious anæmia'. The work of William Hunter began in the year 1888. Between 1888 and 1890 he developed his views as to the hæmolytic nature of the disease, its toxic cause and gastro-intestinal site ; and between 1890 and 1900 he elaborated and expounded his thesis that the disease owned an infective etiology. In 1907 he wrote : "Addison's anæmia is in truth a very remarkable disease, of a specific infective hæmolytic nature, in which both clinical observations and necropsy reveal definite hæmolytic and infective processes as a constant feature of the disease, and in which a very definite series of points can be got out of the history throwing light on the mode of origin of the disease, and the source of the infection in the alimentary tract, and of the lesions of the tongue, stomach, and intestine connected with it".

The treatment of pernicious anæmia by arsenic was introduced by Byrom Bramwell.

It has long been the custom to speak of anæmia as '*primary*' and '*secondary*' ; the latter being the consequence of some disease or dyscrasia, one of whose manifestations is expressed in terms of blood-change ; the former being a change occurring in the blood apart from any other change in the body. The definition of an anæmia as 'primary' involves a belief in the existence of the blood as an organ whose cells are capable of undergoing degeneration or destruction as the consequence of a morbid process limited to itself. But as Vogel points out,* the blood is not itself an organ, but is the direct product of the activity of the various hæmopoietic organs or systems, and may in a sense be more properly regarded as a secretion than as an organ. The erythrocytes having relinquished their nucleus can no longer be regarded as true cells ; and the leucocytes have the power of reproduction only in a very limited degree, if at all. The terms 'primary' and 'secondary' therefore do not hold the meaning they are intended to convey.

Within the normal blood the elements are in a state of unceasing change. This change, nevertheless, maintains the blood in a state of equilibrium. Cells are constantly dying, and undergoing destruction ; and cells are constantly being formed to replace those which are lost. An anæmia may result in consequence either of the diminished production of red cells or of the increased destruction of red cells, or perhaps of both. The anæmias which arise as a result of diminished production of red cells include those seen in cachexias, wasting diseases, tumours, toxic anæmias, aplastic anæmia, etc. The anæmias which arise as a result of the increased destruction of red cells include those seen in cases of hæmorrhage, in hæmolytic icterus, in the anæmias due to hæmolytic poisons, pyrodin, phenylhydrazin, toluylenediamine, etc., and some forms of intestinal parasite, and so forth. In the latter group pernicious anæmia is included. There is in this disease, as Mott first showed, an abnormally great cell destruction, with a pathologically increased demand on the blood-forming tissues rather than an inadequacy on the part of these to meet the normal demand. But to say only this is to say no more than is true of the condition hæmolytic jaundice ; yet, whatever the affinity between these two diseases may be,

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* *Jour. Amer. Med. Assoc.*, 1916, lxvi, 1012.

their clinical manifestations and their destiny are very dissimilar. In pernicious anæmia the red-cell-forming tissue in the bone-marrow is also profoundly affected by the hæmolytic poison, and is subject to a double stress; it is stimulated to over-production at a time when it is fighting to ward off the attack of a poison attempting its destruction. So great is the effort of the bone-marrow to meet the demand made upon it that the parent cells of the erythrocyte are liberated before their offspring daughter and granddaughter cells are created. The greater the urgency of the demand made upon the bone-marrow, the earlier is the type of cell liberated and set adrift in the circulation. The character of the nucleated cell set free may therefore be an index of the gravity of the disease. Death occurs in pernicious anæmia because of the persistence of the increased destruction of red cells at a time when the efforts of the medulla to form blood break down under the ceaseless heavy strain imposed upon it. It will be recognized at once that the conditions existing in this disease, in so far as the changes in the blood and in the organs producing blood, are concerned, resemble those seen in the embryo; a "reversion to the embryonal type of hæmatopoiesis" is spoken of as a characteristic of the disease.

If, then, the disease is primarily a hæmolytic process, a process in which red-cell destruction is the outstanding feature, what is the nature of the poison, and whence does it come? Hæmolysins of definite origin are known. In the hæmolytic anæmia of pregnancy a definite hæmolysin has been found in the placenta. In the anæmia due to bothriocephalus, cholesteryl oleate, set free by the decomposing segments of the worm, affords the poison for the red cells, although every harbourer of this parasite is not equally susceptible to the action of this substance. In some forms of cancer, especially of the stomach and ascending colon, poisons appear to be liberated which cause a blood-picture hardly distinguishable from that of pernicious anæmia. Chronic carbon-monoxide poisoning among charcoal workers, industrial-lead, and perhaps also arsenic, poisoning appear to operate in the same manner. It is suggested that hæmolytic substances formed by pathological bacteria in the intestine may gain access by this route, as first suggested by Hunter.* J. H. King,† after careful study of three cases of pernicious anæmia treated by splenectomy, and after conducting a series of experiments upon dogs, concludes, "In pernicious anæmia, hæmolytic jaundice, and cirrhosis of the liver, the hyperactive spleen unfavourably influences the anæmia through its regulation of the highly hæmolytic unsaturated fatty acids of the blood. The removal, therefore, appears to be indicated. Splenectomy of itself, besides influencing the production of hæmolytic, unsaturated fatty acids, raises the percentage of antihæmolytic substances in the blood; that is, the total fats and cholesterins".

The work of the surgeons in the last few years has afforded some evidence, if not as to causation at least as to associated conditions, in cases of pernicious anæmia. N. M. Percy, whose work on this difficult disease has been marked by a most earnest devotion and remarkable success, has pointed out that since his attention was especially directed to the testing of Hunter's view of the infective origin of pernicious anæmia, he has found evidence of infective foci in 95 per cent of cases. In a consecutive series of nine operations for pernicious anæmia, all specimens removed (spleen, gall-bladder, appendix) were sent at once for pathological examination. Bacteria were grown from 3 of the 9 spleens, from 4 of the 7 gall-bladders, and from 6 of the 7 appendices. The only case not giving a bacterial growth was one in which pyorrhœa had long been present. The chief organism found was the hæmolytic streptococcus (7 cases); in 5 the *Bacillus coli* was found; in 4 *Streptococcus viridans*. Smithies, of Chicago, has grown bacilli and cocci of the hæmolytic type from infected areas about the teeth, tonsils, and accessory sinuses. In a series of 24 cases, preceding the 9 just mentioned, Percy records the following gross lesions. In 20 there was chronic cholecystitis with or without gall-stones; in 17 of these there was evidence of old disease in the appendix; in 6 there were infective foci in connection with the teeth, and in 1 in connection with the tonsil.

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* *Brit. Med. Jour.*, 1907, ii, 1299. † *Arch. of Internal Med.*, 1914, xiv, 145.

A detailed description of the symptoms and the diagnosis of pernicious anæmia is not necessary. But I may be allowed to quote from a description kindly sent to me by Dr. N. M. Percy, of Chicago, whose experience of the surgical treatment of this disease is unsurpassed. Dr. Percy has been impressed with the importance and constancy of the following conditions, and believes them to be of such importance that their presence or absence may well decide the diagnosis in a difficult case :—

1. *Achlorhydria.*—In all cases where a test was made, with one exception, no trace of free hydrochloric acid was found in the fasting contents and in the specimens of test meal. The exception was a very early case, and showed a very low hydrochloric acid content. A few cases were in such an extreme condition that it was not deemed advisable to subject them to the strain of passing the stomach tube. In all other cases the gastric analysis was part of our routine in making the diagnosis. The absence of free hydrochloric acid occurred with such regularity that I would hesitate to make a diagnosis of pernicious anæmia in any case showing the presence of free hydrochloric acid in the stomach unless it be a very early case and the acid content very low.

2. *Tongue.*—The appearance of the tongue was noted in every case, which revealed a peculiar smooth, glossy surface. In some this was present only on the sides of the tongue, in others its whole surface was involved. This appearance of the tongue, which was always present but in varying degrees, is due to an atrophy of the mucous membrane and sometimes due to a hyperplasia of the tongue muscle bundles. A glossitis was present in a large per cent of our cases. Hunter lays particular emphasis upon the lesions in the mouth, and claims there is no other anæmia in which glossitis is so constant and persistent. The appearance of the tongue is so constant that it may be considered the most important external sign of pernicious anæmia.

3. *Pigmentation.*—Pigmentation was found to be present in the majority of cases, especially on the backs of the hands. In some this may be diffuse, in others freckle-like.

4. *Hypertension (chronic nephritis).*—It is noted that hypertension (chronic nephritis) frequently co-exists with pernicious anæmia, both probably being due to chronic infection, but have no definite connection with each other. The cases having high blood-pressure were of middle age or beyond. Strange as it may seem, the hypertension persists through periods of severe weakness and with a blood-count as low as one million or under, only letting down when the patient becomes extremely ill in the terminal state of the disease.

The disturbance of renal function which accompanies marked cases of pernicious anæmia, as pointed out by Christian, was noted in many of our cases. The disturbance is similar to that found in patients with advanced nephritis, but is not accompanied by hypertension or any other evidence of chronic nephritis. The disturbance seems to be due to the anæmia, and subsides as this improves. It is important from the standpoint of prognosis to determine in each case whether the disturbance of renal function is due to the anæmia or to chronic nephritis.

5. *Diarrhœa and Vomiting (intermittent).*—Attacks of diarrhœa and vomiting, especially the former, were frequently noted, and were found difficult to control by medical means. These cases yielded readily to blood transfusions, followed by administration of large doses of hydrochloric acid. Vomiting invariably stopped immediately after transfusion, and the diarrhœa usually subsided within a few days. In a number of instances an attack of diarrhœa was the first symptom of the disease noted by the patient.

6. *Nerve Manifestations.*—The nerve symptoms noted were many and varied, ranging from the most common, that of tingling in the fingers and toes, to those simulating tabes and multiple sclerosis. The tingling sensation in the fingers, the presence of which varies from time to time, was noted in practically every case. Marked psychical disturbances were noted in some cases.

The characteristic appearance of the tongue, the pigmentation, and the achlorhydria occurred with such constancy that their presence may often be the deciding factors in the diagnosis.

Splenectomy in Pernicious Anæmia.—In the year 1913 three observers independently, and for different reasons, suggested the performance of splenectomy in cases of pernicious anæmia. Eppinger* advocated the operation because he had observed a diminished output of urobilin, and other evidences of diminished hæmolysis, after the spleen had been removed for other conditions ; and he assumed that in pernicious anæmia, a disease of exaggerated hæmolysis, the removal of the spleen would control or counteract this tendency. De Castello† was guided by the observations of himself and others as to the great benefits resulting from the operation in the related conditions splenic anæmia and hæmolytic jaundice. Klemperer‡ was influenced by the clinical observation that splenectomy for such simple conditions as laceration was, in some instances at least,

* *Berl. klin. Woch.*, 1913, xxix, 2409. † *Deut. med. Woch.*, 1914, xl, 639.
‡ *Therap. d. Gegenw.*, 1913, liv, 385.

followed by polycythæmia. Advocacy by all of these men of great repute soon led to a wide adoption of the practice in Germany, and an adoption, not so general, in America. In England very little was done. The results, which were not long in coming, showed that the mortality of the operation was high, that the immediate benefit which not seldom followed was transient, that post-operative complications were frequent, and that, with few exceptions, the general course of the disease was not materially altered. That splenectomy alone might offer help seemed probable from the work of Robertson,* who found, in cases studied by himself, that the rate and degree of hæmolysis in pernicious anæmia underwent a constant and marked decrease after removal of the organ. Largely owing to the work of W. J. Mayo and his most able band of colleagues, and of N. M. Percy, a wider view of the necessities of these cases was taken, with a great improvement in results. The anæmic condition of the patients was improved by transfusion of whole blood; and foci of infection, possibly 'primary', but certainly co-existent, in the mouth or accessory sinuses, or in organs laid bare by the abdominal operation, were removed. The purpose of the extended operations consisted, as Percy said, of three main factors: (1) An attempt to stimulate the production of new blood by massive 'step-ladder' transfusions of whole blood; (2) An attempt to overcome the absorption of hæmolytic bacteria or their toxins by the radical removal of local foci of infection; and (3) An attempt to protect the newly-formed and older red cells by removing the spleen. Each of these steps is important. The 'step-ladder' transfusions bring about an elevation, step by step, of the quality of the patient's blood in respect of red cells, hæmoglobin content, etc.; they supply blood which is not only useful in itself, but acts also in a manner stimulating and nourishing to the bone-marrow, encouraging it to still further efforts. The eradication of active foci of infection relieves the patient of a chronic toxæmia which is possibly an etiological factor. The removal of the spleen reduces the abnormal amount of blood destruction. Discussion has recently ranged around the question as to whether transfusions frequently repeated are competent of themselves to produce an improvement in the patient's condition equal to that seen when both transfusion and splenectomy, or these two with the addition of the eradication of infective foci, are undertaken. Under what circumstances may these steps of treatment be taken? They are useless in the 'aplastic type', and they are of little value, if any, in cases where cerebral or spinal symptoms are already present, unless the anæmia is profound, when transfusion alone may give some degree of transient benefit. In all other cases the repetition of a blood transfusion about every eight or ten days gives very striking results. They are briefly stated by Percy:—

> The red blood-count is increased, often doubling immediately if the count is very low. The hæmoglobin percentage rises and the number of platelets is increased. The blast-cells become more numerous, and occasionally Howell's particles will appear in the blood, indicating a stimulation of the bone-marrow. The general appearance and the appetite of the patients improve at once, the condition of the mouth (glossitis is not infrequent) clears up, and sleep returns. It is not only that new blood is given; it appears certain that a great stimulation of the (under-nourished?) bone-marrow occurs. In those patients who are much improved by transfusions the question of splenectomy should be considered; it should not be countenanced unless such improvement has been unmistakable. Before it is performed, a search for foci of infection outside the abdomen will have been made, and all accessible disease removed. When an abdominal operation is undertaken its scope must be comprehensive. Percy's work has shown how necessary a wide inspection is, and how safe the extended procedure may be made. In a private communication he tells me that in 77 laparotomies performed by him the spleen, gall-bladder, and appendix were removed in 54 cases; the spleen and gall-bladder in 11; the gall-bladder and appendix in 4; the spleen alone in 4. There were 8 deaths. In 74 of these patients one or more transfusions had been performed before operation; in 40 a transfusion was undertaken immediately after operation; in 10 cases a later transfusion was performed.
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> Of the 69 cases that left the hospital, 5 had recurrence of symptoms at the end of four months, and died at intervals of eight to twelve months; 10 had recurrence at end of six to eight months and followed about the same course. Forty-eight were in good condition at the end of twelve months. Of these, 12 are alive at the end of two years, 9 at the end of three years, 4 at the end of four years, 5 living nearly five years after operation, and 1 a little over six years. Two of the five-year cases have been retransfused, one several times, the other only twice. The one living six years

* *Arch. of Internal Med.*, 1915, xvi, 429.

since operation has had no transfusion since operation. Two of the four-year cases have been back for transfusions, as have also 4 of the three-year cases, 5 of the two-year cases, and 8 of the one-year cases.

The progress of the 4 cases in which gall-bladder and appendix were removed without the spleen was not so good, in any instance, as was the average of other cases. They did not experience the immediate remission of the average case of the other group, and all of them had an early recurrence of their anæmia, which had been temporarily improved by the transfusions. The spleen was not removed in these patients because it was not enlarged and there were no adhesions to indicate that there had existed a splenitis or perisplenitis. It is evident that some of our patients should not have been operated upon, as undoubtedly just as good or better results would have followed transfusion alone.

There were 45 cases treated by transfusions without surgical procedures other than those for the eradication of local foci of infection when present. In 10 of these, most of which were of the aplastic type, no marked improvement resulted. In 12 cases, all of which presented evidence of cerebral or cord involvement, some improvement was noted in the blood-picture and general condition, but the nerve destruction progressed, without interruption. In 23 cases the transfusions brought about a marked improvement, and in some a very rapid remission of the disease resulted. In no instance was the remission as complete as it was in several of the cases which were operated. The longest remission noted following a series of transfusions was eleven months; the majority, however, required transfusions at much shorter intervals. There are still 2 patients enjoying fair health after the lapse of nearly two years since their first transfusion.

Dr. W. J. Mayo has very kindly given me the record of all cases of splenectomy performed in the Mayo clinic up to Sept. 20, 1920. The following are the results in the cases of pernicious anæmia :—

There were 53 cases with 3 deaths, a mortality of 5·6 per cent.
Five patients were living between four and five years after operation.
Eleven patients were living between three and four years after operation.
Twenty-two per cent of patients lived two and a half times as long as the average.

What may be said, then, of the efficacy of splenectomy in this disease? In the first place it cannot be claimed, and is not claimed, that any patient has been cured of his disease. The risks run in undergoing the operation are small, but not so insignificant that they can be ignored. A few lives are sacrificed. All the patients who survive are not benefited, but in the majority a degree of improvement results, and a prolongation of life, in greater comfort and with increased zest, can be recorded. The truth is approximately this, that as a result of repeated transfusions of blood, removal of the spleen, and eradication of all foci of infection, one-quarter of the patients are greatly improved, living happier and more useful lives, prolonged beyond the expectation by a period of two or three years ; one-half of the patients are improved in some degree, they feel better, take nourishment better, sleep better, and live perhaps a few months, or even a couple of years longer than the average ; the remaining one-quarter of the cases do not receive any help greater than that which could be derived from careful medical treatment, which may include the 'step-ladder' transfusions of blood if these are found to be helpful, and the treatment of such foci of infection as can be found in the mouth, nose, or accessory sinuses. When the position is accurately stated to patients who suffer from this disease, they are likely to decide the matter according to their temperaments. Surgeons should rarely, or never, urge operations, for they should rarely, or never, find it necessary to do so if the problem to be decided is fully and honestly stated to a patient or his relatives. In cases of pernicious anæmia an operation is indicated for those patients who are found by such tests as I have mentioned to be likely to do well, and who are eager to get the most out of the remainder of their days and to prolong them.

LEUKÆMIA.

(*See Fig.* 231.)

To turn over the pages of the history of leukæmia is to see recorded in orderly succession many of the chief features in the growth of our knowledge concerning human pathology and hæmatology. A case of this disease was first recorded in 1845 by Hughes Bennett, of Edinburgh. The spleen was greatly enlarged, and the blood, examined after

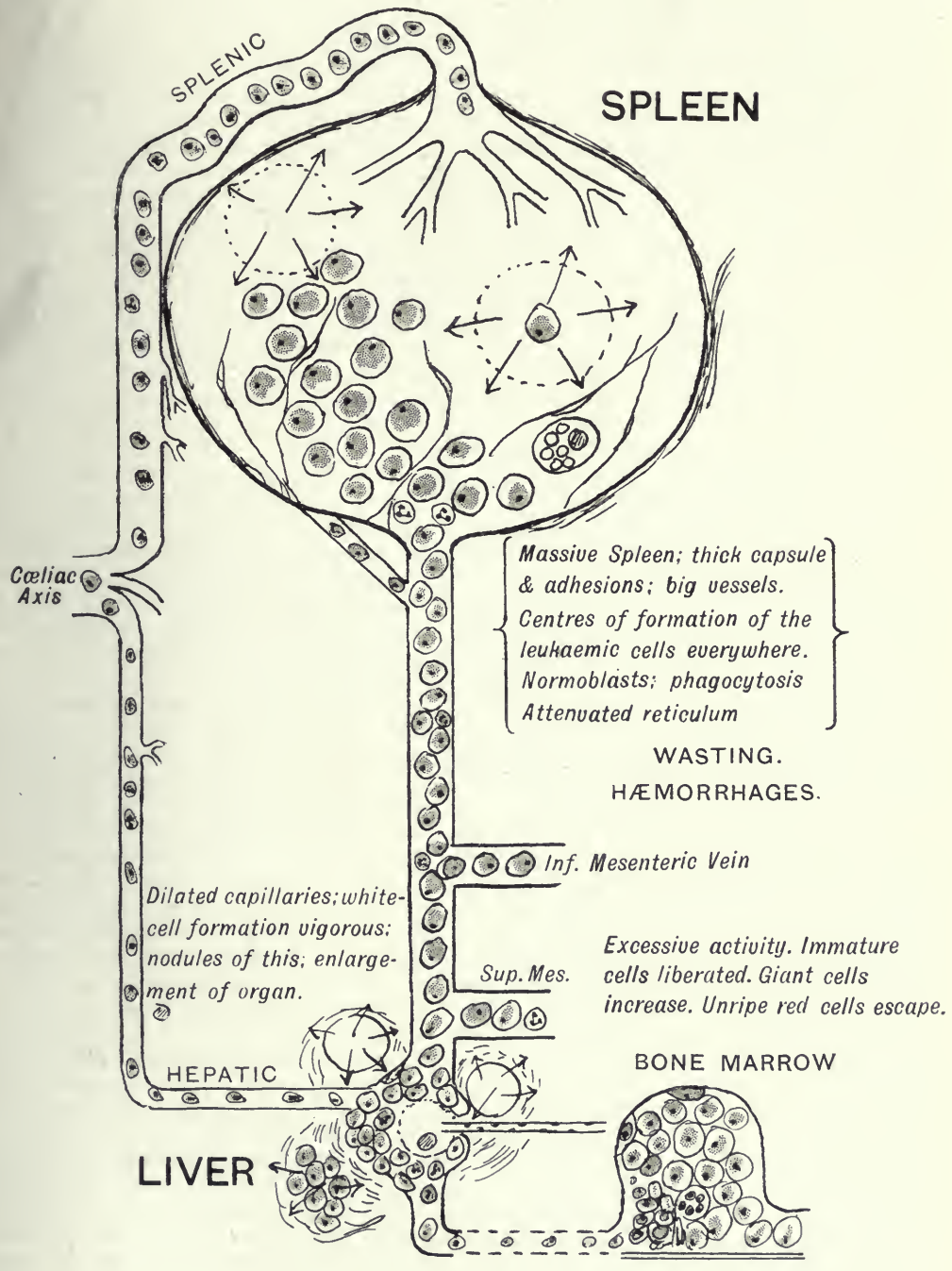

Fig. 231.

THE CHIEF CHANGES IN LEUKÆMIA.

death, was seen to contain a large number of cells similar to those found in the ordinary purulent discharges from wounds. Hughes Bennett described the condition as one of "suppuration of the blood". One month later Virchow described a similar case. A rather acrimonious contest for priority arose, and different views were expressed as to the nature of the white bodies found in the blood. Virchow asserted that they were not to be distinguished from the colourless corpuscles or leucocytes of the blood. Hughes Bennett had regarded them as pus-cells. But the discussion lost all its significance when it was recognized that pus-cells and leucocytes were identical. Virchow, we may well suppose, was interested, not so much in the purely clinical phenomena which his case displayed, as in the question of its intrinsic nature. He regarded "the blood as a transitory tissue with a fluid matrix, constantly changing because constantly developing", and he showed that the cells of the blood are continually perishing and continually being replaced. The occurrence of a disease such as this was for him the confirmation of his opinion as to the nature and constitution of the blood, for he had, as it were, foreseen that such a disease as this would be likely to exist. When once his prediction that there was a 'white blood' was confirmed by the examination of the blood in this disease, the problem at once arose as to the nature of the process involved in the excessive production of leucocytes, and as to the nature of the tissue changes present in this disease.

The study of these questions led to an intensive study of the cellular processes occurring in suppuration. Neumann, in 1878, showed the active part played therein by the bone-marrow, and Ehrlich (1898) demonstrated that it was possible by using aniline dyes as stains to differentiate between the various types of cell activity awakened by this process. From this time, the knowledge of the floating cells of the body has advanced with great rapidity; and the intimate relationships which exist between the cells circulating in the blood, the cells in the blood-forming organs, and the cells met with in inflammatory infiltrations of all kinds, have by degrees been brought to light. The changes in the blood of living patients were first described in 1846 by Dr. Fuller, of St. George's Hospital, and Dr. Walshe, of University College Hospital.

Virchow sought to place the primary seat of this disease in the spleen and in the lymphatic glands. He believed that the changes in the blood arose from the liberation into it of chemical substances which were normally retained within these organs. The cells of the blood were stirred to a greater activity by these substances, and ultimately the cells of the various organs also showed evidence of hyperplasia.

The original belief of the great pathologist received corroboration from Neumann's discovery of the state of the bone-marrow in this disease. As a result of this, leukæmia was then regarded as a disease of the spleen, lymph-glands, and bone-marrow, an interpretation not essentially different from that held to-day. But the subsequent history of this disease shows many vicissitudes. Difficulties were continually arising in the interpretation of details; and in spite of most assiduous research by many observers, no real advance was made in our knowledge of the disease until the work of Pappenheim.

As a result of the investigations of this worker and his school, the origin and fate of every type of cell found not only in leukæmia but in every 'blood' disease, and in every inflammatory process, was thoroughly investigated by special staining methods applied to all manner of tissues: to those removed by operation as well as to those obtained by post-mortem examination, in man as well as in animals.

The modern science of hæmatology received immense impetus from all this work, and a host of earnest students in all lands were eager to lend their help. The question in this disease resolved itself into an inquiry as to whether the abnormal blood-cells were formed in one organ or in many, thence to be distributed to all parts of the body; or whether the cells were formed 'locally', that is, in the parts where they were found. It was an old problem re-stated, the problem as to whether the exudates occurring in inflammation were due to chemiotaxis and the migration of leucocytes from afar; or whether (as was the original view) these cells are developed at the seat of the disease. The general opinion of those most competent to express one, now appears to be that the origin both of these

inflammatory cells and of the leukæmic cell-infiltration is local. This is a matter of great interest, and the historian will recall that in the year 1863, Beale, a solitary voice heard only to be opposed and derided, stoutly defended his opinion that the phenomena of tissue infiltration were the result of the irritation of the endothelial cells of the smallest local capillaries.

Leukæmia may therefore be considered as a morbid process manifesting itself diffusely, and consisting of hyperplasia of various leucocytes—sometimes of the lymphocytes, sometimes of the myeloid cells scattered throughout the body. The severity of the degree of hyperplasia may be so great, and the type of cells produced may be such, that what is called a 'sarcoid' process results. There are cases in which, however, the newly-formed cells are found in the spleen, lymph-glands, and bone-marrow, but do not enter the blood-stream; the blood on examination is normal. 'Leukæmia' therefore may be regarded as having two relationships: on the one side to the disease known as lymphosarcoma; on the other to Hodgkin's disease.

The search for the cause of this disease would be fruitless without the clear conception that leukæmia is a disorder in the process of the formation of white blood-cells, whose birthplace is the endothelium of the reticulo-endothelial system. We have therefore not to search a particular organ to find the cause of the disease. We have to discover the type of agent likely to affect so diffusely distributed a system of cells. We should be able to explain why, in some cases, the proliferative process goes on outside the blood-vessel and produces a massive deposit of new tissue without altering the appearance of the blood (resulting in Hodgkin's disease), whereas in other cases the proliferating process extends into the lumen of the vessel and allows the myriads of newly-formed cells to enter the circulation and produce a typical condition known as leukæmia.

It was Pappenheim who elaborated the thesis that the virus at work may travel either by the lymphatic channels (producing a 'lymphatic leukæmia') or in the blood-channels (producing a 'myeloid leukæmia'), and that the purpose of an inquiry should be to ascertain the nature of the stimuli or irritants capable of exerting such effects.

Symptoms.—The first and striking clinical feature is that the disease does not always run the same course. On the one hand there are acute forms in which a fatal issue ensues within a few weeks; on the other, the disease may last for many months, or, usually from two to four years, or even, as in a case recorded by Grawitz, for ten years. The duration of the chronic cases depends to a certain extent upon the circumstances of the patient. The necessity for earning a livelihood, even though the work is not heavy, has a very harmful influence upon the course of the disease.

Acute Leukæmia is no doubt commoner than appears from the literature, owing to the non-recognition of cases. It begins very suddenly, and is characterized by the severity of its symptoms, which follow acute tonsillitis or stomatitis. Hæmorrhages, as in scurvy, especially from the gums or nose, form an important feature, and in a few cases general glandular enlargement is noticed. The remainder of the clinical course strongly simulates that of typhoid fever, with rapid wasting, and a degree of mental disturbance which sometimes ends in delirium. Jaundice, when present, is attributed to enlargement of the glands in the hilum of the liver, which cause pressure upon the hepatic duct. An exfoliative dermatitis has been noted. The blood-picture may be either 'lymphatic' or 'myeloid'.

Chronic Leukæmia is usually of very insidious onset. A slow progressive wasting becomes noticeable, and carries with it increasing lassitude, asthenia, and loss of mental activity. In this case also there is a tendency to hæmorrhages, usually from the nose, sometimes from the intestine, or under the skin; infrequently from the gums, from hæmorrhoids, from the stomach, uterus, or urinary passages. Ulceration of the lips and mucous membrane of the mouth is not seldom seen, and may suggest an examination of the blood to confirm a tentative diagnosis. Periods of fever are usual. Physical examination reveals a massive enlargement of the spleen; less massive enlargement of the liver; in the 'lymphatic' cases there is enlargement of the lymph-glands in various places. Every system of the body may show changes, so that patients in respect of their most

troublesome symptom may come before ophthalmologists, dermatologists, gynæcologists, urologists, and surgeons, as well as physicians.

Studies in the metabolism of this disease have been extensively made. Perhaps the chief change in this respect has reference to the metabolism of the purin bodies. Uric-acid excretion is high; indeed, uric acid calculi may form. Charcot-Leyden crystals have been found in the blood and tissue-juices after death.

When a patient suffers from an added infection, the enlargement of the spleen and lymph-glands may diminish, and return almost to the normal; the blood-picture alters, the myelocytes disappear, and the polynuclear leucocytes greatly increase. The change, however, lasts only so long as the infection is present. As that fades away the conditions of the disease return. The injections of normal splenic extract, or of spermin, or of cinnamic acid, have restored the blood-count to normal for a time. As mentioned later, the administration of benzol produces a profound change in the state of the blood. Some cases have been reported in which a concurrent tuberculous lesion led to shrinkage of the spleen.

Neither age nor heredity appears to have any influence upon the disease. It does not occur in epidemics. Injuries have sometimes been considered a cause. Animals, cows, horses, dogs, cats, and fowls are said to suffer from the disease. So far no bacterial cause for it has been discovered, in spite of arduous and protracted search. Many of the clinical features could be easily explained as the result of a microbic infection; the acute form is clinically very similar to one of the acute specific fevers. It is true that many organisms have been found associated with the disease: micrococci, staphylococci, in lymph-glands; streptococci in the acute cases seen in America; and other organisms. These are instances, almost certainly, rather of chance secondary contaminations than of causative agencies. Attempts have been made to transmit the disease experimentally by the injection, intraperitoneally or intravenously, of leukæmic blood, but no success has followed. Transmission has occurred from one fowl to another. An examination of the abnormal leucocytes has shown peculiar cell-inclusions, but no evidence exists that these are to be regarded as parasites. So many of the features of the disease are 'toxic' that a further research for a biological cause is worth while. It has been suggested that the 'toxic' features are due to secondary infections occurring in patients whose normal protective neutrophile leucocytes are gravely diminished in numbers and in efficiency, being overwhelmed by the abnormal cells. It is possible that the absence of the normal leucocytes may account for the wasting seen in this disease, for many of the processes enacted in the tissues are deprived of the help which it is the part of these cells to give.

Treatment.—Until recent years no treatment seemed to have any considerable effect in cases of leukæmia. In the year 1909, Selling, of Johns Hopkins Hospital*, reported three cases of poisoning by benzol, two being fatal. The patients suffered from purpura hæmorrhagica with aplastic anæmia, and the bone-marrow was found aplastic. The red cells showed no changes other than slight pallor and anisocytosis. No regeneration forms of the red cells and no normoblasts were found. Platelets were few. There was a diminution in the granular type of leucocytes, and a relative increase in mononuclear types. Leukopenia was present.

In 1912, Koranyi† observed the effects of benzol poisoning in girls working in a factory where benzol was used as a solvent for rubber. The symptoms produced by this drug suggested to him the possibility of its use in the treatment of leukæmia. In reporting his experience, he states that there were no failures with benzol in cases of chronic leukæmia; that the spleen and lymph nodes were little affected; that benzol given alone was of benefit, but, although more gradual in its effect than the *x* ray, it succeeded where this failed; and that patients responded better to benzol treatment after the spleen had been exposed to *x* rays. No serious ill-effects were observed to follow the treatment, but certain disagreeable symptoms were noticed: a sense of burning in the stomach, and the eructation of

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* *Johns Hop. Hosp. Bull.*, 1910, xxi, 33. † *Berl. klin. Woch.*, 1912, xlix, 1857.

offensive gas, with transient catarrh of the trachea and bronchi, and giddiness. In one case the white cells were reduced from 220,000 to 8000 within three months; and the general health improved considerably. Dr. Frank Billings,* who reports a series of five cases treated by this drug, was impressed with it as a very powerful agent, and as one apparently of great promise in the treatment of leukæmia; but it was 'a two-edged sword' which, used carelessly, might defeat the purpose of its use and produce an equally serious condition, namely aplastic grave anæmia, with a hypoplastic bone-marrow, and result in a fatal issue. He noted a diminution in the size of the spleen, a rapid fall in the number of the leucocytes, and, in all the cases of a myelogenous type, an improvement of the red-cell count and hæmoglobin. Later experiences have confirmed many of these opinions; but it was soon found that there were cases resistant to treatment by benzol, and that in others a short period of improvement was followed by a rapidly fatal termination. Such dramatic endings to the disease occur both without treatment and with other forms of treatment, but benzol seemed often to be a factor in causing an earlier death than had been anticipated. The pure drug is administered in capsules containing about 1 grm., and olive oil is given simultaneously to diminish the irritating local effect. A dose of 5 grms. daily is gradually reached. When the leucocyte count is reduced to 20,000 the administration is stopped. Boardman† states that 16 out of 100 cases failed to show improvement, and that another 8 cases, although reacting favourably at first, died during or soon after the discontinuance of treatment.

The application of radium produces the most astonishing effects in reducing the size of the spleen. Within eight or ten weeks a spleen which appears to occupy almost the whole of an enlarged abdominal cavity shrinks until it is only just palpable beneath the costal margin. If the abdomen is marked week by week to indicate the size and shape of the tumour, the evidences of rapid shrinkage are very remarkable. As the spleen diminishes, the general condition of the patient steadily improves, and the blood-count approximates to the normal. In a very interesting paper Ordway† discusses the whole question of radium therapy very fully, and illustrates the improvement seen in cases under his care by photographs. He draws the following conclusions:—

1. Surface applications of radium in leukæmia produce striking, indeed remarkable, improvement in: (*a*) The blood-picture, which becomes almost normal; (*b*) The size of the spleen and glands, which are reduced almost to normal; (*c*) The general condition of the patient, who, from being emaciated and weak, may become plump and strong.

2. The duration of the remission is variable; it may last from months to years.

3. The results of radium treatment are not regarded as curative. It is believed to be, however, the safest as well as the most prompt palliative measure in cases of chronic leukæmia, whether refractory or not to benzol or *x*-ray treatment.

From the results of radium therapy in leukæmia it is believed to be the best form of treatment now at our disposal.

The fact which was clearly established by this work and by similar experiences at the Radium Institute in London in cases under the care of Hayward Pinch, led to the inference that the spleen might possibly be a factor of greater significance in the etiology of the disease than had been supposed. This view was strengthened by the further experience that the exposure of the long bones, or other parts, as well as the spleen, to the action of radium, did not produce results in any degree better than those in which the spleen alone was treated. As a result of the work at the Mayo clinic, by W. J. Mayo, Balfour, Giffin, and others, it seemed not improbable that if the spleen were a factor of causal significance, its removal, when it had been greatly reduced in size by the application of radium, and when the patient's condition was at its best, might be of benefit to the patient. In the old days removal of the spleen has been undertaken because the organ was grossly enlarged; the new view was that the smaller the spleen the safer its removal would be.

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* *Jour. Amer. Med. Assoc.*, 1913, lx, 595.

† Quoted by Ordway, *Boston Med. and Surg. Jour.*, 1917, clxxvi, 490.

The first case in which the spleen was excised in myelogenous leukæmia is recorded by T. Bryant, in 1866,* and the second by the same author in 1867. Both patients died as a direct consequence of the operation; in both the spleen was very large. After this splenectomy, was performed on many occasions in this disease, and by no means all of the cases found their way into surgical literature. The condition in most of these was profoundly unfavourable; the patient was in grave ill-health, and the spleen was of very large size; indeed, only those patients appear to have been selected for surgical treatment in whom the mammoth spleen was a serious and burdensome discomfort. The mortality up to the year 1900 is said to have been just under 90 per cent. Bessel Hagm† gave the records of 42 cases, with 38 deaths, and 'temporary improvement' in 4. I know of a few cases, all fatal, occurring before this date, which never found their way into the literature. In 1908, J. B. Johnston‡ recorded a further 7 cases, of whom 2 lived to show slight improvement after the operation.

H. Z. Giffin§ reports that the total number of cases appearing in the literature up to Jan. 1, 1918, is 51. Of these, 43 died at once: 8 showed a temporary improvement; but of these, 4 died within so short a period of the operation that their death should count as a fatality from it. If this is done the mortality is to be reckoned as 93 per cent. It is not surprising to find that all voices speaking with authority, such as Bland-Sutton's, were raised against a continuance of such surgical work. The record was a martyrology.

The experience of the Mayo clinic is epitomized in the following summary by Dr. Giffin:—

1. Twenty patients with myelocytic leukæmia have been splenectomized—18 of them after preliminary treatment by means of radium exposures over the spleen. The spleen and the leucocyte count were very much reduced by means of radium, and the general condition of the patients was greatly improved.
2. One patient died—an operative mortality of 5 per cent. The operative mortality of cases reported in the literature in which little or no preliminary medical treatment had been given was 86 per cent.
3. Ten of the 20 patients are living in good general condition from nine months to one year and seven months following splenectomy. However, these patients have not yet outlived the life expectancy for the disease.
4. Of 7 patients operated on within six months of the onset of the disease, 6 are alive.
5. It is probable that, at least in certain chronic types of myelocytic leukæmia with fibrous spleens and relatively low leucocyte counts, splenectomy may be justifiable for the comfort of the patient.
6. A review of the cases at this time reveals no evidence that the duration of the disease is altered in any definite way by splenectomy.

The statistics of the Mayo clinic up to Sept. 20, 1920, which Dr. W. J. Mayo has kindly given to me, show a total of 26 cases with 1 death, a mortality of 3·8 per cent. The immediate mortality is therefore strikingly different from that which occurred when the cumbersome size of the spleen was the chief indication for the removal of the organ. The last report shows, too, that 5 patients are in good condition and 2 in fair condition after periods of time beyond the life expectancy of the disease. It is interesting to learn that two cases, supposed to be early examples of myelogenous leukæmia (not included in this list) have been cured, or at least have lived many years after the operation. Dr. Mayo writes: "The operation is not difficult after radium treatment, and in selected cases should be further considered".

HODGKIN'S DISEASE.

In the year 1831, Hodgkin, Lecturer on Pathology at Guy's Hospital, observed a series of cases in which the spleen and the lymphatic glands were enlarged.‖ Among these were four examples of the condition now known as 'Hodgkin's disease'. All

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* *Guy's Hosp. Rep.*, 1866, xii, 444.
† *Arch. f. klin. Chir.*, 1900, lxii, 188.
‡ *Ann. of Surg.*, 1908, xlviii, 50.
§ *Med. Record*, 1918, xciv, 1020.
‖ *Trans. Roy. Med. Chir. Soc.*, 1832.

remembrance of this paper seems to have been lost, for in the year 1862 Wilks, then Lecturer on Pathology at the same Hospital, described the same disease under the title 'anæmia lymphatica'. By the year 1865 Wilks had, however, discovered the previous description by Hodgkin, and though his own observations were entirely original, he suggested, as a title for the disease, the name it has ever since borne, 'Hodgkin's disease'.

The morbid anatomy of the condition has been investigated since by a great number of observers, among whom Reed, Longcope, and Andrewes deserve special mention. A number of diverse views have been held as to the nature and causation of the condition.

One of the most recent writers, Mellon,* considers that the disease has not any relationship with tuberculosis—as Sternberg asserted,—with lymphosarcoma, or with pseudoleukæmia. The prevailing view of most of those who have recently investigated the condition appears to be that all these diseases should be regarded as disorders of the reticulo-endothelial system, probably infective in origin, and therefore to be classified as infective granulomata or "lymphomatosis with granulation-tissue formation". In his review of recorded cases Mellon found only two in which it seemed possible that the spleen was the primary focus of the disease; in neither was an autopsy obtained, yet the necessity for this could not be better shown than in a case recorded by Mellon as coming under his own care. In this there was no evidence of glandular enlargement, and a primary splenic origin of the disease seemed most probable. After death the inguinal, bronchial, and retro-peritoneal glands all showed hyperplasia of the lymphoid cells, and endothelium with multinucleated giant cells. The spleen showed advanced changes; the lymphoid tissue of the splenic pulp was practically obliterated by the intense proliferation of the hyaline connective tissue. There were many areas of anæmic necrosis which indicated that the disease in the spleen was of long standing. A similar case was recorded by Wilks in 1856. The patient was a man who died in Guy's Hospital in an extremely debilitated and anæmic state, with an enlarged spleen. The autopsy showed that the mediastinal and lumbar glands were very much enlarged, although the superficial glands were quite healthy.

The true nature of the disease has baffled inquiry. It may be regarded as a separate and distinct disorder having no ostensible attachment to any other. Or, alternatively, it may be regarded as a special form of a certain type of morbid process which exists also in other conditions—tuberculosis, pseudoleukæmia, and lymphosarcoma. The latter opinion has the advantage of correlating various morbid states as to the nature of which there has long been confusion, and attributing them all to one common underlying cause.

Hodgkin's disease has, as its essential anatomical feature, the presence of tumours made up of granulation tissue. The lesions differ from those of tuberculosis partly in the heterogeneous character of the inflammatory cells concerned in the formation of the nodules, and partly in the fact that the original cells of the affected tissues undergo active multiplication. The ordinary structure of the glands or spleen becomes lost in the abundance of lymphocytes, which appear intermingled with those epithelial cells, giant cells, fibre cells, and eosinophile leucocytes, all of which together help to build up the masses found in Hodgkin's disease.

In the reticulo-endothelial system there are the following two types of disease. There is that in which the cells undergo an intense proliferation and are liberated into the blood, as in the leukæmias. And there is that in which the proliferation goes on outside the vessels without the entry of any of the new cells into the blood. The microscopist, studying the spleen and allied organs, might well believe that he had an ordinary leukæmia tissue under examination, although the clinical phenomena might make such a diagnosis impossible. For him, the nature both of Hodgkin's disease and of leukæmia is essentially the same, and the state of the blood (upon which the clinician lays so much stress) is a mere incident. The following classification, for help in the preparation of which I am indebted

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* *Amer. Jour. Med. Sci.*, 1916, cli, 704.

to Dr. Gruner, embraces all the disorders of the reticulo-endothelial system, and shows, as well as our present knowledge allows, their relationship to each other :—

Disorders of the Reticulo-endothelial System.

I. *Those in which there is an excessive formation of specific tissue elements.*

A. With the appearance of cells which are normal to blood-forming tissues :—

1. The cells grow away from the vascular channel :
   i. The disorder is disseminated throughout all parts of the system : (Disseminated) Pseudoleukæmia.
   ii. The disorder is *focal.*
      a. In the lymph-glands : Lymphomatosis ; also in Typhoid lesions.
      b. In the bone-marrow : 'Medullary Pseudoleukæmia'.
      c. In the spleen (and liver) : 'Lienal Pseudoleukæmia'.
2. The cells grow partly into the vascular channel, so that myelocytes appear in the blood : Acute Specific Fevers ; von Jaksch's Anæmia.
3. The cells grow mainly in the vascular channel. Therefore large numbers of myelocytes (or lymphocytes) appear in the blood :
   a. Disorder in the lymph-glands or lymphatic tissues : Clinically acute or chronic Lymphatic Leukæmia.
   b. Disorder in the bone-marrow, spleen-pulp, or any 'myeloid' tissue : Clinically acute or chronic Myeloid Leukæmia.

B. With the appearance of entirely new cells :—

1. Definite tumour-formation :
   a. Widely disseminated through the body : Lymphosarcoma.
   b. Only local masses : in the spleen : Lymphosarcoma.
   in the bone-marrow : Myeloma.
   in the lymph-glands : Chloroma.
2. Definite tumour formation not present, but tumour cells are intermingled with myelocytes or lymphocytes of large size : 'Sarcoid' Leukæmia.
   (Each of these may also show 'leukæmic' blood.)

II. *Those in which there is excessive formation of the stroma cells.*

A. One kind of cell is noticeably predominant in the tissues :—

1. Fibre cells : Passive Congestion of the Spleen ; Syphilitic Splenomegaly ; Malaria ; Kala-azar ; Cirrhosis with Splenomegaly.
2. Epithelioid cells : Gaucher's Splenomegaly.

B. Many cell-types involved, so that a granulation-tissue tumour is formed :—

1. Disseminated through the whole system : Hodgkin's Disease ; Lymphogranuloma.
2. Local, e.g., in the spleen only (very rare) : primary Hodgkin's Disease ; Tuberculosis of Spleen ; Gummata of Spleen.

III. *Those in which there is an excessive formation of stroma cells with disturbance of the formation of the specific tissue-cells* : Pernicious Anæmia ; Splenic Anæmia ; Hæmolytic Jaundice ; Splenomegaly in Rickets.

The histological study of these diseases suggests a similarity, if not an identity of causation, both for the widely disseminated lesions, and for those in which a definite 'tumour', such, for example, as lymphosarcoma, occurs.

The clinical symptoms of Hodgkin's disease are very familiar. They are largely mechanical in origin, and are due to the presence of widespread glandular enlargements which may press upon important structures. The periodic pyrexia of this disease may be regarded as a specific and typical feature. It is uncertain as to whether it is sometimes, or often, the result of secondary infections.

The symptoms certainly suggest the existence of a definite infection. There is a latent period, with occasionally slight swellings of the glands. A stage of declared disease may then begin quite abruptly. There may be a sudden general enlargement of the lymphatic glands, which themselves cause pressure symptoms, recurring attacks of fever, with increased heart action, and progressive wasting. It is said that the blood often shows no change, but it is very probable that an increase of the large mononuclear leucocytes and transitional cells is generally to be expected.

Treatment.—It is only very rarely that an operation upon the spleen is necessary in a case of Hodgkin's disease. I have performed one such operation. The case occurred in a man, 44 years of age, who had a colossal enlargement of the spleen with no discoverable change in any of the lymph-glands. Under radium the spleen diminished rapidly in size, but after two months again began to increase and became as large as ever. A second and third application of radium caused an equal reduction, and when the spleen was small I removed it. It showed the typical evidences of Hodgkin's disease, and this diagnosis was confirmed by the later enlargements of the cervical glands on both sides, which receded after the application of radium. The original operation was performed twenty-two months ago, and the patient is still in good health and at work. It is very doubtful if the removal of the spleen has had any effect, good or ill, upon the progress of the disease.

The general treatment of the disease needs no mention here.

SPLENIC ANÆMIA. BANTI'S DISEASE.

(*See Fig.* 232.)

Historical.—'Banti's disease' is the name given to the condition described in 1883,* and again in 1894,† by Guido Banti, of Florence. In 1866 Gretzel‡ described a clinical condition of anæmia associated with splenomegaly to which Griessinger applied the name 'splenic anæmia'. The case occurred in a child 10 months old who suffered from dysentery and severe anæmia, with considerable enlargement of the spleen, and enlargement, less considerable, of the liver and lymphatic glands. Examination of the blood showed that the proportion of white to red cells was not increased; the condition was therefore not leukæmic. In 1871 Wood § described a 'splenic form' of pseudoleukæmia, and reported a case in which the spleen was greatly enlarged, and there was severe anæmia without leucocytosis. Banti, in his later description mentioned above, considered the disease as possessing clinically three stages, merging gradually into each other. These stages were: (1) One in which there was enlargement of the spleen and a secondary anæmia—the duration being three to twelve years; (2) One in which the liver gradually enlarged, and the amount of urine underwent progressive diminution—the duration was brief; (3) One in which the liver gradually shrank in size and ascites appeared, the symptoms being those of an ordinary atrophic cirrhosis—the duration of this stage was between one and two years. The disease was invariably fatal, and death occurred either from hæmorrhage, or from auto-intoxication from cirrhosis.

In a third publication, Banti ‖ asserts that the disease is also characterized by the following definite pathological changes: (1) The chief change noted in the spleen is a fibrosis of the Malpighian follicles, spreading outwards from the central artery, which often shows a hyaline degeneration; (2) There is fibrosis of the splenic reticulum, with narrowing of the splenic veins, a thickening of the splenic capsule, and of the trabeculæ, larger and smaller, running through the organ; (3) Endophlebitis, with calcification of the splenic veins, extending up to, and even into, the portal vein; (4) Cirrhosis of the liver, of the 'Laennec type'; (5) The characteristic red marrow of a secondary anæmia; (6) There is no general glandular involvement.

Banti's hypothesis is that there is a primary splenomegaly due to an infectious agent. The splenic enlargement itself produces another toxin which, acting on the liver and on the splenic veins, produces the changes just described. The anæmia is the result partly of the toxæmia and partly of the hæmorrhages. The hypothesis is unnecessarily complex, for there is no reason why a single infective agent should not produce effects alike in the liver and in the spleen. The production by a sclerosing organ of a toxin destined to cause sclerosis in another organ is unknown elsewhere.

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* "Dell. anæmia splenica," *Arch. L. Schula Anat. pathol.*, Firenze, 1883, ii, 53.
† *Sperimentale*, xlviii, 407.
‡ *Berl. klin. Woch.*, 1866, ci, 212.
§ *Amer. Jour. Med. Sci.*, 1871, lxii, 373.
‖ *Folia Hæmatol.*, 1910, x, 1.

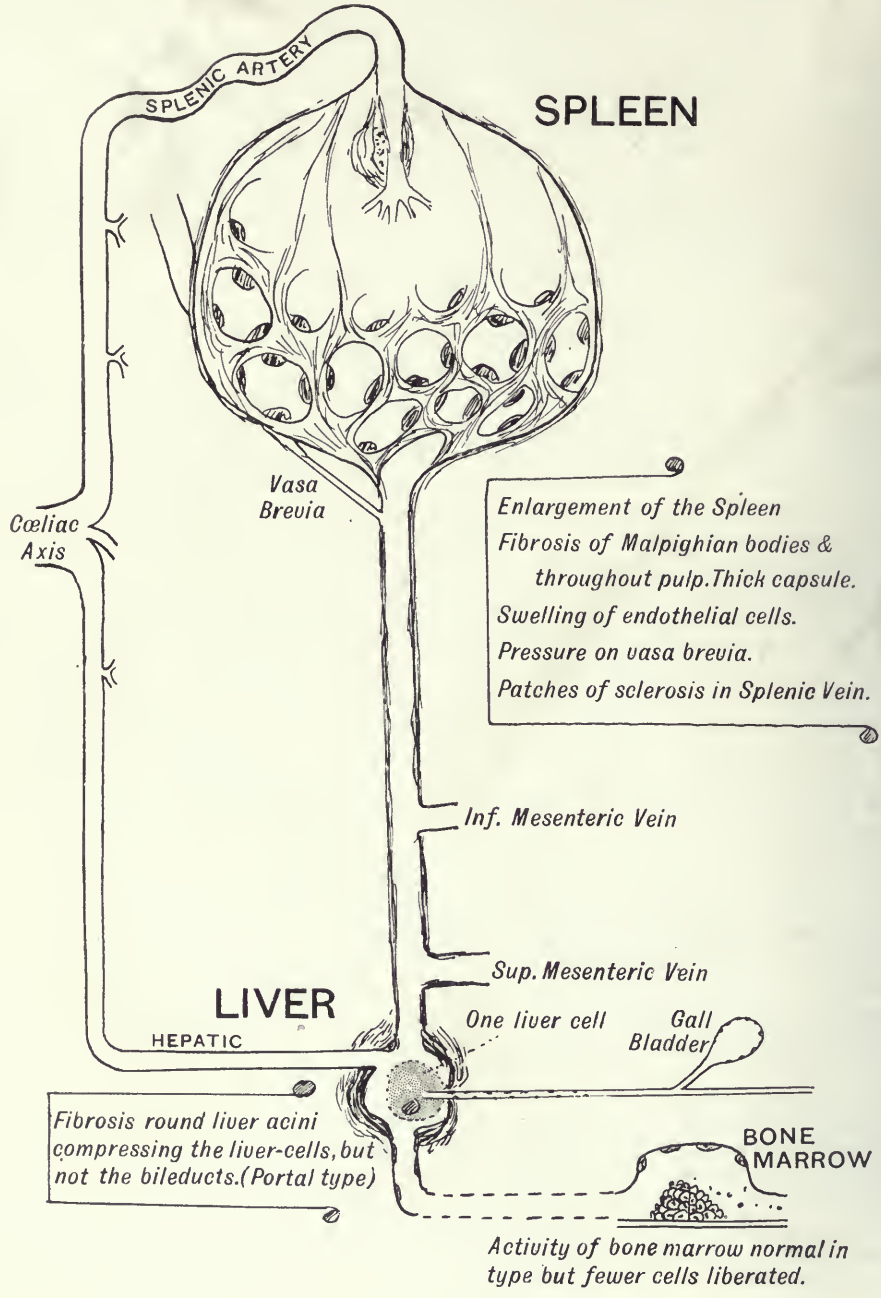

FIG. 232

THE CHIEF CHANGES IN SPLENIC ANÆMIA.

The difficulty in the strict recognition of Banti's disease, as he describes it, is great; for there are many conditions with symptoms very closely resembling those described by him, and the chances of obtaining a pathological examination of the spleen and its vessels, and of inspection of the liver, are so remote, in view of the restriction of operative treatment, that an accurate diagnosis is only then obtainable after death. The etiology in Banti's disease is held to be unknown. If, therefore, a case clinically and pathologically resembling Banti's disease has a known causation, it cannot be accepted as an example of this disease.

Again, both clinically and pathologically the conditions in certain cases may so closely resemble those of Laennec's cirrhosis that many authors have considered that there are not two diseases, but one disease with different names.* If the ordinary clinical course is followed, there is no doubt that in Banti's disease the splenic enlargement precedes the affection of the liver, whereas in Laennec's cirrhosis the liver is first attacked; though in some cases the splenic enlargement may be so considerable as to distract attention from the less obvious change in the liver.

The truth appears to be that a large clinical group of cases, distinguished by enlargement of the spleen and a secondary anæmia, is being gradually encroached upon by keener distinctions than formerly existed, pathological and etiological. Griessinger's original description of splenic anæmia included, for example, the condition we know now as Gaucher's disease, the disease now called 'hæmolytic jaundice', and that form of infantile pseudoleukæmia called von Jaksch's disease. In connection with the latter, the view is taken by some observers that it is an infantile form of Banti's disease in which "a moderate leucocytosis, due to the higher values of leucocytes in the normal blood of infants, is to be found" (Mayo).

Splenomegaly associated with anæmia may have its etiology determined and so be withdrawn from the group of 'splenic anæmia'. This has happened, for example, in connection with chronic syphilitic enlargements, with the enlargements due to kala-azar, to malaria, and so on. The group is raided from every side. What remains? Only the forms of 'splenic anæmia', the cause of which is unknown. Or, as Mayo wisely and wittily says, "Put in the form of an Hibernianism, incomplete knowledge is essential to the diagnosis. If we know the cause of splenic anæmia it is not splenic anæmia". 'Banti's disease' and 'splenic anæmia' are therefore synonyms for the same condition, the former title indicating especially the later, the latter the earlier, stages.

Clinical History.—Splenic anæmia was defined by Osler as "an intoxication of unknown nature characterized by great chronicity, primary progressive enlargement of the spleen which cannot be correlated with any known cause, anæmia of a secondary type, with leukopenia, a marked tendency to hæmorrhage—particularly from the stomach,—and in many cases a terminal stage with cirrhosis of the liver and jaundice". The clinical features of the disease then are the following:—

1. *A very chronic course*—in which the symptoms progressively and steadily increase in severity, without amendment, and without any hope of spontaneous recovery.

2. *A slowly progressive enlargement of the spleen.*—This is the first of all evidences of disease; the bulk of the organ undergoes an increase, at first apparently slight, but later more rapid. The ratio of increase probably remains unaltered throughout. The enlargement may finally be very considerable, though it is rare for the spleen to become as large as in myeloid leukæmia, or in some cases of Hodgkin's disease, or in malaria, or in Gaucher's disease. The spleen is not altered except in bulk, so far as physical examination shows: the surface is smooth, the notches apparent; there is no tenderness, nor is a friction rub felt or heard. It is said that a 'bruit de diable' has been heard (Sippy, Rolleston) "due to eddies produced by slight torsion of the dilated veins in the gastrosplenic omentum or of the splenic vein". Seeing that clinical recognition of splenic enlargement is not possible until the spleen is at least double the normal size, it is more than probable that the inaugural and early symptoms of splenic anæmia are quite unrecognized.

3. *Changes in the blood* are of the type found in secondary anæmia. The red cells may drop to less than 2,000,000 per c.mm.; the average number is one-half of the normal. The colour-index is low. In a series of fifteen cases Osler found the number of red cells to be 3,425,000 per

* Krull, *Mitteil. a. d. Grenzgeb., d. Med. u. Chir.*, 1915, xxviii, 718.

c.mm. and the hæmoglobin 47 per cent. A recent hæmorrhage will of course affect the count very considerably; though it has often been observed that recovery after a hæmorrhage is rapid, and that within two or three weeks the blood-count may so improve as almost to reach the normal. The white cells are never above the normal unless there has been a recent hæmorrhage, or an inflammatory complication is developing. Leukopenia is the rule. In Osler's case the average count was 4520.

4. *The tendency to hæmorrhages* is remarkable. Hæmatemesis especially is seen, occasionally with copious melæna. Other forms of bleeding are also mentioned in recorded cases; epistaxis, purpura, and hæmaturia are the most commonly seen. The amount of blood lost, especially from the stomach, may be enormous. I have seen two cases in which the apparently pure blood vomited within a couple of hours measured over three pints. Osler records a case in which three quarts of blood were lost within thirty-six hours. Recurrence of the hæmorrhage is frequent. A remarkable case is related by Hutchison and Ledingham* of a woman who was admitted to the London Hospital on account of severe hæmatemesis no less than thirteen times within a period of fifteen years. The blood comes in such cases, it is believed, from œsophageal varices and dilated vasa brevia, both of which are found in a large proportion of the cases.

5. *Affection of the liver.*—In the later stages of the disease the liver enlarges, and presents the clinical pictures of Laennec's cirrhosis. Ascites is present with the hepatic enlargement, or in some cases without it. This terminal condition, in which the liver is enlarged and dropsy is present together with the earlier conditions described, is often spoken of as 'Banti's disease'; but if this latter term is retained it is perhaps wiser to use it only as a synonym of 'splenic anæmia'.

6. *An unknown causation.*—The discovery of a cause for the splenic condition removes the case from the category of splenic anæmia. As I have said, the term 'splenic anæmia' as originally used included a group of diseases characterized by certain clinical features common to them all. Upon this group encroachments have steadily been made, and may well continue to be made, as our knowledge of the etiology of special diseases becomes by degrees more accurate.

7. *Other phenomena of less importance* may briefly be enumerated. A general enlargement of lymph-glands is not present. Until the latest stage there is no alteration of the urinary function. Occasional attacks of heaviness in the epigastrium, flatulence, and indigestion are observed, which lead, when hæmorrhage occurs, to a diagnosis of 'gastric ulcer'. Such dyspepsias are less frequently seen than might be supposed. Rarely there may be slight pigmentation of the skin. If jaundice is present the case is not one of splenic anæmia.

The Differential Diagnosis.—This as a rule is not difficult. The mistake I have most commonly seen is the making of a diagnosis of *gastric* or *duodenal ulcer*. I have now seen five cases in which a patient suffering from splenic anæmia was referred to me as an example of these diseases. The absence of a clear history of dyspepsia, the presence of an easily palpable spleen, and the blood changes, soon revealed the true condition. The contrary mistake may be made. Rolleston relates the following case† :—

> "Some years ago a middle-aged man was under my care in St. George's Hospital. He was very anæmic, and with a history of recurrent hæmatemesis. There was a tumour which appeared to be an enlarged spleen, and the condition was regarded as splenic anæmia. The necropsy showed that the tumour was a large hydatid cyst in the left kidney, and that a chronic gastric ulcer was responsible for the repeated hæmatemesis."

In any doubtful case an *x*-ray examination would almost certainly clear away the uncertainty and demonstrate the presence of a chronic gastric ulcer.

Cirrhosis of the liver has occasionally presented difficulties in diagnosis. The number of cases in which the splenic enlargement is considerable, and the hepatic enlargement slight, must be excessively small. That the spleen may be much enlarged in cases of Laennec's cirrhosis is certain; and in such a condition a copious hæmatemesis might well raise a doubt as to the true diagnosis. Naunyn and others consider that splenic anæmia is merely a type of hepatic cirrhosis in which the liver changes are relatively slight, at least until the final stages are approaching. If a patient is first seen when the spleen is grossly enlarged, the liver cirrhotic, ascites abundant, hæmorrhages recurrent, and ill health and emaciation advanced, it is not certainly possible to say whether the case is one of advanced Laennec's cirrhosis, or is in the terminal stages of Banti's disease. The accurate diagnosis is, however, made without difficulty if the earlier stages of the disease are carefully sought.

Syphilitic enlargement of the spleen and liver may be associated with a moderate

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* Allbutt's *System of Medicine*, v, 759. † *Practitioner*, 1914, April, 480.

degree of anæmia. In such cases the symptoms of splenic anæmia are reproduced with remarkable accuracy. The differential diagnosis is achieved by a close study of the history, by a discovery of a positive Wassermann reaction, and by a recognition of the effects of antisyphilitic treatment. The latter, however, is not always successful. W. J. Mayo records five cases* in which he removed enlarged spleens in conditions of chronic intractable syphilis with severe anæmia, when the patient has been resistant to careful treatment for syphilis, carried out during a period of several months. After removal of the spleen the anæmia rapidly disappeared and the syphilis was cured with comparatively mild antiluetic treatment such as had previously failed to affect either the syphilitic condition or the spleen. Coupland records a case in which the spleen was removed for 'splenic anæmia' with much benefit; the patient died two years later, and syphilitic disease of the liver was found.†

Chronic obstruction of the splenic vein.—Many years ago Dock and Warthin‡ called attention to the occurrence of phlebitis and calcification in the splenic vein, in cases in which the group of symptoms and signs associated with splenic anæmia was present. Other changes in the splenic vein in similar cases have been recorded by various observers. These are summarized by Rolleston§ as follows:—

The splenic vein may be:

1. Reduced to a fibrous cord;
2. Represented only by a plexus of veins, as in a case in which hæmatemesis occurred at intervals of ten months for twenty years;‖
3. Thrombosed as the result of extensive endophlebitis.**
4. Occluded by an organized thrombus at its proximal end.††

These various morbid changes may be different stages of the same process, but the sequence of events may vary: thus endophlebitis may undoubtedly cause thrombosis, and it is quite possible that organization of a primary thrombosis may be followed by endophlebitis and calcification.‡‡

In cases such as these the differential diagnosis is impossible. The view that all cases of splenic anæmia are the result of changes such as these in the splenic or portal vein cannot be sustained. In some cases of splenectomy for splenic anæmia, it is true, these changes may be found, in greater or less degree, and at times they have been known to embarrass the operator by causing a difficulty with the ligation of the pedicle, and troublesome hæmorrhage. But in the great majority of instances no such changes are discoverable, though recently search has been carefully made for them.

The influence of trauma in exciting phlebitis and thrombosis in the splenic or portal vein must be remembered. Ledingham§§ writes that "many cases which showed symptoms of splenic anæmia or Banti's disease have presented a history of previous severe abdominal injury, and that thrombosis of the portal vein, with consequent splenomegaly, anæmia, and moderate cirrhosis of the liver, has been proved on several occasions to follow injury". A recent case in my own experience confirms this association of early and severe trauma with the symptom-complex of splenic anæmia.

Moschowitz, in an admirable summary and discussion of the subject of Banti's disease,‖‖ calls attention to the simulation of this disease by cases in which there is persistence of the umbilical vein. In recent years four such cases have been described in which the clinical symptoms were closely similar to, or identical with, those of Banti's syndrome. There was also a hypoplasia of the liver attributed to persistence of the vein, which on post-mortem examination was found enormously dilated in all cases, and communicated

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* *Trans. Amer. Surg. Assoc.* 1919, xxxvii, 483.
† *Brit. Med. Jour.*, 1896, i, 1445.
‡ *Amer. Jour. Med. Sci.*, 1904, cxxvii, 24.
§ *Practitioner*, 1914, xcii, 479.
‖ Langdon Brown, *St. Bart's. Hosp. Rep.*, 1901, xxxvii, 155.
** Oettinger et Fiessinger, *Rev. de Méd.*, 1907, xxvii, 1109, etc.
†† Bland-Sutton, *Proc. Roy. Soc. Med.*, 1913, vi, 239.
‡‡ Thompson and Turnbull, *Quart. Jour. Med.*, 1911, v, 291.
§§ Allbutt's *System of Medicine*, v, 759.
‖‖ *Jour. Amer. Med. Assoc.*, 1917, lxix, 1045.

in some with the deep hypogastric or deep epigastric veins. The unusual and excessive amount of blood carried in this vein caused a damming back of blood in the splenic vein, which in turn was responsible for the gigantic overgrowth of the spleen.

The Pathogenesis of Banti's Disease.—The fact of utmost significance in connection with the causation of this disease is that it is cured or arrested by removal of the spleen. This fact may be accounted for, either by assuming that the disease is primarily and essentially located in the spleen, or by assigning to the organ the rôle of modifying the action of some agent situated elsewhere in the body.

If the disease is primarily splenic, a search for a specific microbic infecting agent should ultimately be successful. Hitherto no convincing evidence of this has been found, although Hollins has argued strongly in favour of incriminating the colon bacillus. There is scope for further research in this direction; and the organ removed during life, if straightway examined, should provide profitable material for routine bacteriological investigation.

The enlargement of the spleen has been attributed to excessive hæmolytic activity by those who consider the disease to begin in some other part of the body. But such a view does not sufficiently explain the fibrosis which is the outstanding histological feature of the disease. A chronic infective process would account for the enlargement as well as the fibrosis, and accord better with the absence of undue hæmolysis of the red blood-cells. In splenic anæmia the red cells never show 'fragility'. If there is a change the corpuscles may show increased rather than diminished resistance.

The anæmia, in like manner, may be regarded as an incident, or as an essential part of the disease. Rolleston, a very distinguished authority, does not regard the anæmia as primary; he believes it to be secondary to attacks of very severe hæmorrhage, chiefly because he finds that regeneration of blood takes place after these events. This view, however, is, I think, subject to the criticism that such severe hæmorrhage is not invariable, and that the substance elaborated in the spleen need not be capable of affecting the bone-marrow until after it has left the liver, where it has undergone modification. Further, whatever the poisonous substance may be, it need not completely arrest blood-cell development. A parallel case is, I think, sometimes furnished by subjects of leukæmia in which an intercurrent infection supervenes, with a temporary restoration of the normal blood-picture.

Hollins regards the disease as being due to an active 'intoxication' produced by the colon bacillus, whose 'colilysin' brings about the anæmia, whilst its actual presence in both spleen and liver accounts for the fibrosis of each organ. This view would put every kind of cirrhosis of the liver on the same level, because 'colilysins' could not be expected to vary radically in their action. The facts would be better met were it suggested that the spleen harbours various organisms, some of which only excite a local fibrosis, others induce a simple cirrhosis of the liver, and still others produce that form of cirrhosis associated with Banti's disease, with a toxic anæmia and other specific symptoms.

In respect of the hæmorrhage which is so conspicuous and alarming a feature of some cases, Rolleston considers that the enormously distended vasa brevia rupture into the stomach as a result of the torsion of the splenic vein caused by the great bulk of the organ. This opinion is certainly correct in many cases. The hæmorrhage is so profuse and so swiftly escapes from the stomach that large vessels must be implicated. Such vessels as Rolleston describes are often seen in operations upon cases of splenic anæmia when abundant hæmatemesis has occurred. But this cannot, I think, be the whole explanation. The relationship between enlargement of the spleen and gastric hæmorrhage is cryptic, but certain; for, as Balfour was the first to show, removal of the spleen may cure a patient whose life has been jeopardized by severe and recurrent hæmorrhages from the stomach. Gastric hæmorrhage is known to be toxic in origin in certain cases, as for example those in which there is a lesion in the appendix, intestine, or gall-bladder; and those also in which the lesion lies in the spleen or liver, or both.

Treatment.—The only treatment for splenic anæmia is splenectomy. The appropriate moment for the removal of the organ is chosen. It is inadvisable to operate soon

after a grave hæmorrhage, or when the spleen is extremely large. In the latter case the effect of radium on the tumour should be tried ; almost certainly it will cause a rapid and considerable shrinkage in the organ. If this should happily be the case, splenectomy is done when the spleen is at its smallest, and before it has begun to enlarge afresh, as it will certainly do after a few weeks. It is imperative to operate upon cases of this disease as early as possible. No other form of treatment needs consideration ; the dangers and difficulties of the operation increase with the lapse of time ; early operation means a more certain chance of recovery and a quicker convalescence. In the later stages the mortality of operation is higher, amounting to 25 per cent as compared with an average of about 10 per cent. In the terminal stages operation becomes so dangerous that only the inevitably fatal outcome of the unhealed disease justifies its performance.

The degree of improvement that may take place is astonishing, even in the late stages of the disease with advanced involvement of the liver. It is, as W. J. Mayo says, an evidence that the great power of the liver to regenerate its specific cells is utilized to the full.

The difficulties of the operation are greater in splenic anæmia than in any other disease. In almost all cases adhesions binding the organ especially to the under surface of the diaphragm are present. They may be numerous and exceedingly dense, and their separation may cause a copious and grave hæmorrhage. But they are never so dense nor so strong as to prevent the completion of the operation. The details of the operation in other respects are the same here as elsewhere. At the Mayo clinic up to Sept. 20, 1920, 73 operations had been performed, with 9 deaths, equal to 12·3 per cent. The after-results are excellent ; the rather high operative mortality is due to the technical difficulties of the late cases, which, apart from operation, would all be fatal.

HÆMOLYTIC JAUNDICE.

(*See Fig.* 233.)

In his work, *Diseases of the Liver*, Murchison, a well of wisdom, describes cases of chronic slight jaundice occurring in several members of the same family : an association with splenic enlargement is not mentioned. Cases of congenital jaundice and splenomegaly occurring together were first recorded by Claude Wilson in 1890 and in 1893.* Hayem, in 1898, described 5 cases of icterus† similar in character to these, though acquired and not congenital, and presenting certain features in common. There were in all a slight chronic jaundice and normal stools and urine. The absence of such conditions as pale stools, mahogany-coloured urine, and tormenting itching of the skin was especially noted. The spleen in all was large and hard, and the liver a little increased in size. In all anæmia was present, the erythrocytes numbering between one and three millions ; and in all there was a history of acute exacerbations. In none was there any family history of similar conditions ; in three the first appearance of jaundice occurred in adult life.

In 1900 Minkowski described the occurrence of chronic jaundice in eight members of one family, extending over three generations ; in these the symptoms and signs were similar to those described by Hayem, but in addition urobilin was noticed in the urine ; there were pigment deposits in the kidney ; there was enlargement of the spleen as the result of hypertrophy and vascular engorgement ; there was no cirrhosis of the liver.

Two types of disease were thus recognized : the acquired form of Hayem, and the congenital or familial form of Wilson and Minkowski. The former type was more fully described, and its clinical history and blood condition more critically examined, by Widal. The latter type in respect of its hæmatology was especially studied by Chauffard, who first pointed out that the resistance of the red blood-cells to hypotonic salt solutions was greatly diminished. This increased 'fragility' constitutes the factor of chief importance in the disease. Of the two, the acquired form (the 'Hayem-Widal type') is the more serious, and apart from surgical treatment appears to be inevitably fatal.

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* *Trans. Clin. Soc.*, 1890, 162, and 1893, 165. † *Bull. et Mém. Soc. Méd. de Paris*, xxv, 122.

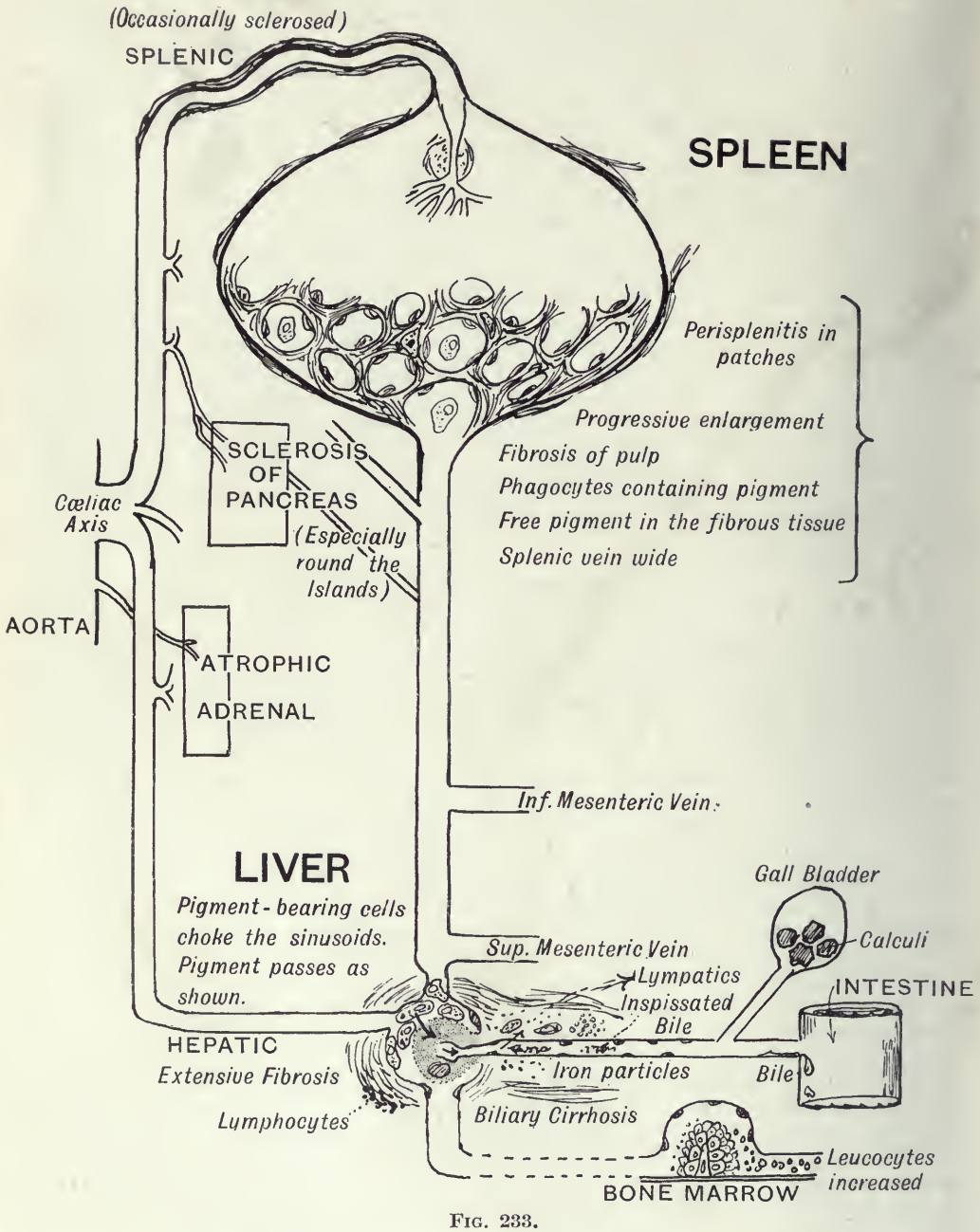

Fig. 233.

THE CHIEF CHANGES IN HÆMOLYTIC JAUNDICE.

The Symptoms in the two types are very similar. There are acholuric jaundice—that is, jaundice with unaltered stools and urine—enlargement of the spleen, and anæmia. There is no itching of the skin, and there is not that degree of rapid wasting so often seen in cases of obstruction to the common duct. The blood changes show a reduction in the number of red cells, an increased number of reticulated cells, and a lessened resistance to hypotonic salt solution. In two of the cases of the acquired type which I have seen, the symptoms have very closely resembled those of obstruction of the common duct by calculus. In both there were exacerbations of jaundice preceded and accompanied by fever, and by pain and tenderness in the epigastrium. In one of these my diagnosis would certainly have been confidently given as 'cholangitis due to calculus', but that a surgeon of great experience had explored the duct and discovered no stone. The diagnosis may be very difficult in cases in which gall-stones also are present. In about 60 per cent of recorded cases stones have been found in the gall-bladder or in the ducts at the time that operation for removal of the spleen was undertaken.

These acute exacerbations during the otherwise tranquil course of the disease were first described by Widal as 'crises of deglobulization'. They are acholuric crises and are due, it is supposed, to massive hæmolytic activity, an activity which Eppinger estimates as being competent to destroy the whole of the red blood-cells in the body within a period of twenty-four hours, with the result of throwing an immense strain upon all the organs of the body concerned in blood production. In these crises there are great malaise; an elevation of temperature to 101° or 102°, increase in the size of the spleen, which may become very tender; a deepening in the tinge of jaundice; acute anæmia, intense hæmolysis with, in the graver cases, a temporary hæmoglobinæmia; and urobilin is found in the urine. More rarely the liver also is enlarged, and the epigastrium is often tender. There is no itching of the skin, and there are no petechial hæmorrhages. It will be seen how close is the mimicry of the symptoms caused by a comparatively small gall-stone floating in a comparatively wide common duct; and remembrance must always be given to the fact that in so large a proportion of cases gall-stones, whether in the gall-bladder or in the common duct, are found at operation. The very worst forms of crises are probably often, if not always, due to impaction of calculi in the common duct, and the evidences of biliary obstruction in the urine and fæces may then be found. Elliott and Kanavel,* in an admirable paper, say that in the crises "one can always find evidence of excessive regeneration, i.e., polychromatophilia, nucleated red cells, and certain reticulated bodies in the red cells stained by vital stains as first recorded by Vaughan".

The distinction between the congenital and acquired forms is real. The congenital form is exceedingly chronic in its duration and quiescent in its manifestations. Chauffard said of patients suffering from this form, that they were 'more jaundiced than ill'. I have more than once been consulted by patients on account of other diseases (loose cartilage in the knee, and carcinoma of the breast) who were suffering from the congenital form of this disease; the jaundice was regarded with as little interest as the colour of the hair. In the familial type of the disease several observers have noted that the condition is of a graver type in the parent; the jaundice is deeper, the crises are severer and more frequent, and complications are more prone to develop. Not a few of the patients, affected though not afflicted by the disease, live their days out in comfort, and die, at advanced ages perhaps, of maladies unconnected with this condition. A few patients have lived to the age of 80, and one at least to the age of 90.

The acquired form may begin abruptly, and run an eager rapid course from the first. Anæmia quickly becomes profound, the red cells falling to one million within a few weeks. The crises of pain, temperature, and deepened jaundice are more frequent than in the congenital type. In one direction the disease, whether congenital or acquired (generally the latter), may wander away into the neighbourhood of pernicious anæmia. Chauffard describes an "icteric form of pernicious anæmia which, when accompanied by diminished

* *Surg. Gynecol. and Obst.*, 1915, xxi, 21.

resistance and reticulated red cells, represents the least compensated form of hæmolytic icterus ". Weissenbach records a case of this type also.

Pathogenesis.—The older views that this disease is primarily hepatic in origin are for ever set aside by our surgical experiences ; for it is known beyond dispute that removal of the spleen 'cures' the patient, who, if the operation has been done in stages earlier than the terminal, remains entirely free from symptoms at all subsequent periods. The spleen, if not the exclusive cause or seat of the disease, exerts the profoundest influence upon its pathogeny.

Several views as to the ultimate causation have been held. Chauffard at first, and Widal later, believed the essential factor to be a dystrophy, an increased fragility of the red cells. This view is held by the great majority of those who have studied the question in recent years. Other authorities, led by Minkowski, hold the opinion that the primary change is an increased hæmolytic activity, probably restricted to the spleen. Widal, the most earnest supporter of the former view, considers that the red cells which are congenitally infirm are destroyed in the general circulation ; their remnants are taken up by the spleen, which undergoes enlargement, forming a tumour for which Ponfick introduced the term 'spodogenous', and also by the bone-marrow, kidney, and liver, all of which are found on post-mortem examination to be deeply pigmented. This opinion has lost ground since the many good results following splenectomy have been witnessed, though, as I shall mention, it does not appear from the very late examination of Sir Spencer Wells's case that the dystrophy of the red cells is always altered even after many years of perfect health following splenectomy. Consequently the altered character of the red cells may be sometimes evidence of faulty manufacture, their lipoid component being deficient, as I have already suggested. This does not nullify the opinion that the spleen has much to say in the subsequent treatment of such defective cells. In my own cases fragility of the red cells disappeared soon after splenectomy, and has not returned. The experience in Spencer Wells's case is, I think, exceptional.

Minkowski's view is held by a few later writers, including Banti, who consider that the spleen is not only enlarged as a consequence of the retention within it of cell remnants, but that within the spleen cells are prepared for destruction and are there actively destroyed. An examination of the spleens removed during life or obtained at autopsy shows no specific change. The deep congestion of the splenic pulp and of the sinusoids, constantly found, is common to many other forms of splenic disease. Occasionally biliary cirrhosis is found at autopsy.

Treatment.—Treatment of this condition is by no means always necessary. The symptoms may be very slight, or may even be absent. If crises occur they may be so infrequent and so speedily pass away that the patient, having suffered from them for years, may pay no serious heed to them. In cases rather more severe, general medical treatment and the use of radium therapy have proved to be valueless. Where the symptoms are troublesome to the patient, and especially so in the acquired form, recourse to operation should be had in as early a stage as possible. It is better not to operate in, or near, a time of crisis, and if the spleen is unduly large its size may be reduced temporarily by the application of radium. Splenectomy has proved to be a specific in this disease. Its dangers are slight ; in Kanavel's collection of 48 cases there were 2 deaths ; in Mayo's series of 32 cases there was 1 death. And the results are excellent. Within a few days the patient loses the tinge of jaundice entirely, all symptoms disappear, and there is never any recurrence. No operation in surgery gives such swift and striking results. It is very remarkable to witness the change in a patient who has been jaundiced for years or from birth ; the skin becomes clear and white, sometimes within forty-eight hours. The first case submitted to operation was recorded by Sir Spencer Wells.* The patient was a young unmarried lady, age 22, who had an abdominal tumour " the size of a young child's head ". The tumour was below the umbilicus, central, elastic, but without fluctua-

* *Med. Chir. Trans.*, 1888, lxxi, 255.

tion. Its movements were closely associated with those of the uterus, and its lower border was felt behind and to the left of the uterus. Sir Spencer Wells was doubtful as to the precise seat and character of the tumour, but thought that it must be either uterine or ovarian. The patient's very florid complexion inclined him to the former view. Since the age of nine the patient had been subject to frequent attacks of jaundice, and the mother said the urine had "always been dark in colour". The operation was performed on Dec. 5, 1887, was followed by a good recovery, and six weeks later the patient's medical man wrote: "I question whether she has for many years past been six weeks without an icteric tinge". It is interesting to note that the patient was alive and well in the year 1914, and Lord Dawson then reported* "that the red cells still showed increased fragility". Two similar cases, in which the symptoms have been completely relieved by splenectomy but the increased fragility remains unchanged, are recorded by Kahr† and Roth, but, as I have remarked, this experience is probably unusual. The matter needs further inquiry.

The second case of hæmolytic jaundice to be treated surgically was operated upon, in 1895, by Bland-Sutton; the result was excellent, and the patient was reported alive and well five years later. Sir John Bland-Sutton tells me that he has not seen the patient for five years, but that she was then quite well. There can therefore be no hesitation in advising operation in all appropriate cases.

Giffin‡ reports that the result of the examination of patients in the Mayo clinic, by the method of Schneider, shows that the quantity of the bile pigments found in the duodenum, always in excess of the normal in this disease, steadily declines after removal of the spleen.

In all operations the condition of other abdominal organs will of course be examined as a part of the usual routine. The association in so many cases of cholelithiasis, and of a greatly-thickened bile, in stages earlier than those of calculous deposit, will involve the removal or the drainage of the gall-bladder, and possibly an exploration of the common bile-duct. No operation for hæmolytic jaundice is complete until the bile-passages have been thoroughly explored. The removal of the appendix will be performed in all cases in which the condition of the patient does not prohibit the very slight additional manipulation.

The results at the Mayo clinic up to Sept. 20, 1920, showed 32 cases with 1 death, a mortality of 3·2 per cent. Like all other statistics of this clinic they represent the results obtained by a group of men of the highest technical skill, working under conditions unsurpassed elsewhere. They show the level which highly organized surgical endeavours can attain, and are an example and an encouragement to all.

DIFFERENTIAL DIAGNOSIS.

The differential diagnosis of the several diseases I have now described is often a matter of grave difficulty. The table which follows on pages 358 and 359, adapted from Krumbhaar, presents the points of similarity and of difference in a form that can be quickly seen:—

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* *Proc. Roy. Soc. Med.* (Clin. Sect.) 1914, vii, 86. † *Verh. d. deut. Kong. f. inn. Med.*, 1913, xxx, 326.
‡ *Surg. Gynecol. and Obst.*, 1917, xxv, 152.

DIFFERENTIAL DIAGNOSIS OF CER

Disease	Etiology	Pathology of Spleen	Family History	Time of Onset	Duration	Icterus	Splee Mega
Gaucher's disease	Toxin ? Infection ? Tumour ?	Peculiar cell hyperplasia	Occasionally positive	Childhood	Many years	Rare	+ +
Splenic anæmia	Toxin ? Infection ?	Hyperplasia Fibrosis	Negative	Adult life	Few years	Rare	+
Acquired hæmolytic jaundice	1. Primary ? 2. Secondary to infection	Congestion and pigmentation	Negative	Any age	Many years	Present	+
Familial hæmolytic jaundice	Heredity	Congestion and pigmentation	Positive	Congenital or childhood	Many years	Present	+
Pernicious anæmia	Enterogenous toxin?	Fibrosis	Negative	Adult life	Few years, with remissions	Very rare	Slight dimini

CONCLUSION.

It is evident that a consideration of the whole subject of diseases of the spleen must take a very wide view. A number of symptoms may direct attention to the spleen, even when clinical examination does not reveal the presence of splenomegaly. It is through the correct insight into the significance of the clinical symptoms and other morbid phenomena that the real understanding of any supposed case of splenic disease becomes possible. Instead of searching only for the existence of this or that splenic disease, *an inquiry should be directed to the determination of the functional capacity of all the various organs* likely to be deranged. The symptoms already named may be looked upon as evidence of some disorder in the particular *systems* now under consideration. This derangement must be regarded not merely as a restriction of the morbid changes to the spleen, but as a disturbance of wide ramification throughout the whole body, affecting one or other, or perhaps even all, of the four systems in which the spleen plays a part. The focus, at the moment, may in truth be in the pulp of the spleen ; but even so, the general picture presented by the patient is the outcome of the participation of the other systems in the process which started in the spleen. It may be that splenectomy in any of these diseases will remove the obvious culmination of the morbid process, and thus bring about a 'cure' of the disease or an arrest of its development ; but it does not by any means follow that all the other related parts are thereby caused to return to their normal states. Absence of symptoms does not imply the restitution of normal functions. The case of Sir Spencer Wells and Lord Dawson (*see* pp. 356, 357) discloses this truth unequivocally. In this case fragility of the red cells was found twenty-seven years after the removal of the spleen for hæmolytic jaundice.

A further step in the investigation of the clinical condition of the patient should aim at the exact discovery of the *site* of the lesion in certain particular cell-types : (*a*) In the spleen-pulp ; (*b*) In the bone-marrow and in any part where reticulo-endothelial cells may exist in specially congregated or active masses ; (*c*) In the liver ; (*d*) In the endocrine organs, including the pancreas. This lesion being predicted, or recognized, the question will arise as to whether it consists in, or entails, the elaboration of poisons capable of causing hæmolysis, cirrhosis, or asthenia.

The tissue affected, and the changes therein resulting being recognized, further research must be directed to the discovery of *the type of infective agent* at work, whether bacillary, spirochætal, or other. In other words, the patient is no longer to be regarded merely as

ENIC DISEASES (*after Krumbhaar*).

ÆMOR-HAGES	ANÆMIA	RESISTANCE OF RED BLOOD-CELLS	RETICULATED RED BLOOD-CELLS	UROBILIN-URIA	LEUCOCYTES IN BLOOD	LIVER	TREATMENT
asionally	Slight	?	?	?	—	+	Splenectomy ?
asionally	Slight to severe	Normal	Normal	+	—	First + Later —	Splenectomy
Rare	Severe	Diminished	Increased	+	—	+ or normal	Splenectomy
None	Slight	Diminished	Increased	+	—	+	Splenectomy
Rare	Severe	Increased	Increased	+	— or +	Normal	Iron, arsenic, etc. (splenectomy and transfusion)

the victim of some type of 'disease', but as the victim of disorders of a certain character in certain parts of certain anatomical or functional systems of the body. It is the form of the disorder, the form of distribution (determined by an assessment of the functional capacity of the several organs concerned or likely to be concerned), which, when correctly studied, will inevitably lead to the source and cause of the morbid state, and ultimately to the prospect of the 'cure' of the patient.

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VISITS TO SURGICAL CLINICS AT HOME AND ABROAD.

MR. JAMES BERRY'S CLINIC AT THE ROYAL FREE HOSPITAL.

The foundations of Mr. Berry's clinic at the Royal Free Hospital in the Gray's Inn Road were laid a good many years ago, for it is more than thirty years since Mr. Berry was first appointed to the surgical staff of the hospital.

These three decades have witnessed the gradual development of one of the most active and interesting surgical clinics in this country, whether considered from an educational or from a purely technical point of view. Mr. Berry has managed to preserve all that is best of the essentially British methods in the teaching of surgery, and to them has added a great deal of the cream of the Continental and American methods. This he has been able to do because of his extensive travels, which have enabled him to inspect the work of most of the famous surgical clinics of the world.

We cannot do better than describe what may be taken to be an average week in Mr. Berry's clinic at the Royal Free Hospital. Operations are done on Mondays, with Friday as a second day should it prove necessary. It is wise to be punctual, for the time announced, viz., 2.0 p.m., is very strictly adhered to. Mr. Berry makes a practice of beginning the operation itself at 2.0 and not merely preparing for it. The list of operations is generally formidable, running occasionally into a dozen, or even more. The theatre system, which is based largely on the ideals which Mr. Berry has himself evolved, is as follows:—There are two theatres. each with an anæsthetic room. These two theatres communicate through the intermediation of a sterilizing room, and when an operation is finished in one theatre the surgeon and his assistants walk through this communicating room to the adjoining theatre where all is in readiness for the next operation. Mr. Berry was one of the first to realize that it is necessary to have a trained team in order to effect the maximum saving of time. At the Royal Free Hospital he has generally two assistants, one senior with some years' experience of his methods, and one more junior corresponding to a house surgeon. In addition there are several dressers, each having a well-defined function in the team. One of the most important factors in the success of the work of this clinic is the anæsthesia, and Mr. Berry has been fortunate in having, in Dr. Dickinson Berry, an anæsthetist who is accustomed to his methods and who has worked with him for many years. A second anæsthetist is available, and helps very much in avoiding the irritating delays between operations which seem inevitable with a single anæsthetist.

Mr. Berry by no means confines himself to goitre and cleft-palate surgery. Attendance at the clinic will soon convince the visitor that, while thyroid surgery is seldom wanting, nearly every type of major operation can be seen from time to time.

The three following operations have been selected for description from a very large number which were seen.

1. *Ligation of superior thyroid artery for exophthalmic goitre.*—A digest of the case was given before the patient was brought into the theatre. A board is provided bearing an abstract of the notes of the case, and this may be drawn up to the gallery by anyone who may be interested to read them. Local anæsthesia is generally selected for this operation. A solution of novocain, 0·5 per cent, without adrenalin, was injected with a

powerful metal syringe at the level of the upper border of the thyroid cartilage; this line is usually indicated by the upper of two transverse creases at the upper part of the neck. After waiting about twenty minutes to allow the local anæsthetic to act, an incision was made in the line indicated, and deepened until the sternomastoid and omohyoid muscles were defined. The artery was found by a little careful blunt dissection between these two muscles, and was then tied in continuity with a single strand of 000 silk. No special attempt was made to include the veins or the whole of the upper pole. All vessels were ligated, the platysma was sewn up with a fine continuous catgut suture, and the skin united with a continuous suture of fine fishing-gut. No drainage is used for this type of case. The operation lasted about fifteen minutes.

Fig. 234.—Mr. Berry in the quadrangle at the Royal Free Hospital.

2. *Resection extirpation of a large cystic adenoma of the right lobe of the thyroid.*—The patient, a woman, age 50, was brought into the theatre to be anæsthetized, as Mr. Berry considers it wise never to allow such cases to be anæsthetized in the anteroom. The dangerous period, where dyspnœa is severe, is during the induction, and should sudden asphyxia occur it will generally be possible to make a rapid incision and deliver the tumour in time to save the patient; but should this occur while the patient is in the anæsthetic room valuable time may be lost. The anæsthetic employed almost invariably for this type of case at Mr. Berry's clinic is open ether preceded by $\frac{1}{100}$ gr. of atropine, but without any other drug. The greatest care is exercised to maintain a very light anæsthesia, so that the minimum of ether is used; and indeed, during the later stages of the operation, the patient sometimes is able to answer questions quite sensibly, without however remembering anything at all about it afterwards. Special attention was given to the proper placing of the patient's head, and the anæsthetist was screened off carefully by a towel held by a dresser or nurse, in place of the wire screen which is sometimes used elsewhere, and which is so incommoding to the surgeon's elbow. A low transverse incision was employed and carried down through the platysma, and the flap so outlined was raised as far as the thyroid cartilage, all vessels being secured with the utmost care. Some large veins underlying the flap were next dissected out and secured with forceps. The

skin flaps were protected by means of flannelette secured to the edges with a special type of towel-forceps ; the wound was held open with a most useful automatic self-retaining retractor.

The muscles were then separated in the mid-line of the neck, the infrahyoid group on the right were next cut through high up near their attachments, and a few small bleeding points in the cut surface of the muscles clamped with artery forceps. Mr. Berry explained the great importance of making sure that the correct layer was reached before separation of the gland was attempted, since failure to do so might land one in very serious difficulties. The middle thyroid vein was now defined and tied off by means of a special aneurysm needle, thus enabling the surgeon to introduce a finger behind the tumour and to dislocate it from its bed. It was noticed at once that the patient breathed more comfortably. The vessels supplying the tumour were now controlled by a series of artery forceps applied round its periphery as near to its attached base as was compatible with avoidance of damage to the recurrent laryngeal nerve, and the thinned-out layer of gland

Fig. 235.—In the wards.

substance which covered the tumour was incised just beyond these forceps down to the level of the capsule of the tumour proper. The posterior part of the adenoma was then separated by blunt dissection, a few more bleeding points were secured, and the whole mass, being now free, was removed, the time occupied up to this point being twenty minutes. The artery forceps were now replaced by ligatures of 000 silk tied with very great care, three half-knots being used in each case, and for the larger vessels the silk was used doubled. No vessels were twisted, as Mr. Berry explained how unsafe this would be. When all had been tied off the patient was made to strain by the anæsthetist (who had allowed the patient to come round partially), who gagged the mouth open and stimulated the back of the pharynx with a swab on a holder. This step tests the efficacy of the hæmostasis, and one bleeding vessel of considerable size was detected and secured. Mr. Berry explained that the one real danger of the operation was recurrent venous hæmorrhage, and that the step just described reduced the risk to a minimum.

The infrahyoid muscles were then united with a continuous suture of catgut, and a separate layer of fine catgut sutures was used to unite the platysma. A short paraffin-

coated glass tube was placed in the middle line and the skin united with a continuous suture of fine fishing-gut, leaving about half an inch at each end unsewn for drainage of the sub-platysmal space.

The operation, which had taken forty minutes, was completed by the application of a most efficient dressing, fixed by means of a bandage which prevents the patient moving the head for the first twenty-four hours. Mr. Berry mentioned that the tube would be removed the next day and that the patient would be allowed to sit out of bed for half an hour on the following day.

Fig. 236.—Operating for cleft palate.

3. *Operation for cleft palate.*—The patient, age 18 months, had a cleft which extended as far as the anterior palatine canal and was of moderate width. Mr. Berry explained that it was not necessary to wait until the child was three years' old, but that he treated each case on its merits ; the simpler cases could often be closed at twelve months or even earlier ; only the most difficult need be delayed until the third year.

The patient was anæsthetized with chloroform, and placed with the shoulders raised and the head extended so as to allow blood to collect in the roof of the pharynx, where it was less likely to prove a danger. A Smith's gag was used, held by a trained dresser. The mucoperiosteal flap was raised, beginning from the cleft and working outwards. The first incision was made with a special right-angled knife, and the flap raised mainly by means of an aneurysm needle which Mr. Berry considers a very useful type of periosteal elevator

for such cases. The next step, the detachment of the soft palate from the hard, was done very thoroughly by means of curved scissors, one blade thrust under the posterior end of the mucoperiosteal flap, and between it and the bone, the other blade on the nasal aspect of the soft palate. This completed, it was then seen that the cleft could be closed without any lateral incisions. The edges of the cleft were now pared, a fine shaving being removed anteriorly, and rather more from the soft palate. A special angled cleft-palate needle of Mr. Berry's own pattern was now used for inserting a mattress stitch of thick silkworm-gut through the soft palate. This stitch is intended as a tension stitch, and is tied over short pieces of rubber tubing. The edges of the soft palate were now brought into exact apposition by means of fine sutures of silkworm-gut which were continued to the very end of the uvula. The hard palate was closed by mattress sutures placed so as to evert the edges and bring broad surfaces of mucoperiosteum into apposition. Mr. Berry explained that the sutures would be left for a fortnight—except, of course, the deep tension suture which is generally removed about the fifth to the seventh day—and that it is wiser to leave them even longer if any sign of breaking down of the line of union should be noticed.

On Wednesdays, at 1.30, consultations are held at the Royal Free Hospital. Mr. Berry's energy and enthusiasm are responsible for the inauguration and maintenance of this most interesting feature of the work of the hospital. Cases are shown by members of the Honorary Staff, medical and surgical, and are examined by all members of the staff present. The patient is then removed, and the case discussed by the staff in order of seniority. At 2.0 p.m. Mr. Berry goes round his wards with his dressers and visitors. He makes a great feature of bedside teaching, and dwells particularly on the essentially practical details of the cases; students are encouraged to examine and handle the cases themselves. The cases operated on the previous Monday are seen, and the notes relating to them read and criticized.

On Fridays, at 1.15, Mr. Berry gives a most valuable clinical lecture, utilizing specimens removed at operation, museum preparations, pictures, and the epidiascope (which he generously presented to the hospital) to illustrate his remarks. The field covered is a wide one, and while avoiding any purely academic teaching, Mr. Berry emphasizes all that is necessary to give the student a complete picture of the diseases with which he deals. At 2.0 p.m. the wards are again visited and the cases to be operated on the following Monday are examined and selected, and the work of the week ends at about 4.0 p.m.

Anyone who has seen much of the work of Mr. Berry at this clinic must come away with the impression of having been in an atmosphere of serious surgery, without any taint of the faddy and ephemeral. The organization of the clinic is as near perfection as possible, and the results are such as would be expected where no effort is spared by all concerned to safeguard the patient's interests from the first to the last.

A CASE OF ASCITES DUE TO A CHRONIC INTUSSUSCEPTION OF SEVERAL MONTHS' DURATION.

By F. M. SPENCER, London.

This case seems worthy of note, in view of the following outstanding features: (1) The age of the patient—a boy of 7½ years; (2) The chronicity of the disease—the first symptoms directly referable to his trouble occurring four months before his parents sought medical advice; (3) The physical signs presented on examination, the most prominent being a tumour situated in the epigastrium, associated with an extreme degree of ascites, and obstructive symptoms; (4) The marked wasting present, with intermittent abdominal pains and occasional vomiting, associated with regularity and even frequency of the bowels.

R. N., age 7½, boy. When first seen, in March, 1920, the child had been complaining of abdominal pains and sickness on and off for four months. The pains at first occurred at intervals of a week or fortnight, but latterly they were more frequent, until they became of almost daily occurrence. They were described as "stabbing like a knife", and were always referred to the umbilicus; they came in spasms, lasted a few minutes, and gradually eased off. At first, each attack was accompanied by vomiting, but later there was no vomiting and only occasionally nausea and retching. The bowels tended to be constipated at first, but were kept open by purgatives, and latterly moved freely of themselves. The mother stated that the stools contained blood on three occasions at the outset of the trouble—once bright red, and twice just sufficient to streak the stools. She also said that the boy "got a lump across his navel" during the attacks of pain, and gurgling sounds were often present. The appetite was good, but wasting was very extreme. He had had no chest symptoms; was not known to be feverish; and had no bladder or kidney symptoms. Previous and family history both good. No trace of tuberculosis on either side of the family.

He had attended the out-patient department of the Hospital for Sick Children, Great Ormond Street, since March 2, 1920, where he had been treated for 'abdominal tuberculosis'. He was admitted as an in-patient on April 16, under the care of Mr. George Waugh, on account of partial obstruction and the increase of the ascites.

On Admission.—The boy was extremely wasted, with thin loose skin, but in no immediate discomfort. Temperature normal. Pulse rapid, 100 per minute, but otherwise respiratory and cardiovascular systems normal. The abdomen was distended, of even contour, and showing free respiratory movements; circumference round umbilicus 22 inches; tenderness in epigastrium, and some guarding of the muscles on deep pressure. An indefinite mass could be made out, running diagonally across the epigastrium, reaching almost from loin to loin. Free fluid in considerable quantity demonstrated, shifting dullness and fluid thrill both being present.

A provisional diagnosis was made of tuberculous peritonitis with ascites and obstructive symptoms. Laparotomy was deferred with the object of getting the child into a state more fit for operation.

During the next few days the child seemed to improve somewhat, but still had attacks of abdominal pain at intervals, resembling cramp in character, and accompanied by nausea, but no vomiting. The bowels moved normally twice daily; no tenesmus; no blood or mucus in stools, which were light in colour and rather loose. On April 22, the sixth day after admission, the patient had a very severe attack of pain, during which coils of distended bowel were seen to rise up under the thin abdominal wall in the right iliac region, and disappear with a gurgle. This attack lasted about a quarter of an hour,

and left the child collapsed and worn. The circumference of the abdomen was now 23 inches at the navel—an increase of 1 inch in six days. A similar attack occurred on April 24, when it was decided that a laparotomy should be done. The usual means were taken to combat the shock, and saline were given to enable him to stand an operation.

Operation.—The abdomen was opened six hours later by Mr. George Waugh under open ether. Several pints of serosanguineous fluid escaped on opening the peritoneum, with no smell, and resembling rather the fluid found in connection with malignant abdominal tumours. Some thick lymph was mopped away from the pelvis. The peritoneum showed little more than vascular engorgement: no roughness and no signs of tuberculosis anywhere. In the upper abdomen a large, firm, and rigidly fixed tumour was found closely bound down by omentum, stretching from one kidney region to the other, and apparently retroperitoneal. The patient's condition did not warrant further examination, and the abdomen was closed.

Examination of the fluid showed: Specific gravity, 1008; albumin, 2·4 per cent; reaction amphoteric. A film showed pus-cells containing bacilli and Gram-negative diplococci; cultures grew streptococci and a few colonies of *Bacillus coli*.

The child seemed to pick up after the operation; but about twenty-four hours later he had several attacks of severe abdominal pain, and became very collapsed, with thin rapid pulse and sighing respirations, and thirty-six hours after operation he died.

It is of particular interest to note that at no time during his eight days' stay in hospital had there been any change in the size, shape, or position of the tumour, so that his bowels were acting regularly with the intussusception permanently present.

Fig. 237.—Photograph showing size of intussusception, hole eroded in the 'sheath', and œdematous intussusceptum. The whole is shown in the position in which it lay in the abdomen. Caput with terminal aperture of intussusceptum was at point X, and consisted of terminal part of ileum with lowest portion of ascending colon.

Post-mortem.—A general peritonitis was found, with thick, purulent fluid, and a strong smell of *B. coli communis* infection. Adjacent coils of gut were covered and bound together by plastic lymph.

The tumour was found to be an intussusception, with transverse colon as a sheath and containing ascending colon and several feet of small intestine (*Fig.* 237). About the centre of the sheath was a hole, through which protruded the engorged and congested mucous membrane of the entering layer. The actual hole measured about 2 by 2½ inches, but the wall of the gut in the neighbourhood of the ulceration was very thin, consisting merely of serosa for an area an inch or so wide. It seems probable that the great size of the head of the intussusceptum, from engorgement and œdema, had thus caused a pressure necrosis of the containing sheath and acted as a ball-valve, and thus prevented leakage in any amount sufficient to cause acute peritoneal symptoms. Therefore the fluid present would be a general peritoneal exudate caused by gradual infection through the damaged bowel wall, and at the time of operation this 'protecting valve' was displaced, allowing a free exit of intestinal contents, which led to rapid and severe general peritonitis.

CASE OF GASTROJEJUNOCOLIC FISTULA WITH STERCORACEOUS VOMITING, FOLLOWING GASTRO-ENTEROSTOMY.

By JOHN MARNOCH, Aberdeen.

E. P. E., male, age 37, married, was of excellent physique and enjoyed unimpaired health until early in 1907, when he began to have vague discomfort in his right lower abdomen. This was variously thought to be due to appendicitis, duodenal ulcer, or some renal trouble. He was passed fit for colonial service, and left for East Africa in the same year. During his residence there he had frequent attacks of discomfort and was sometimes sick, but had no treatment. In 1913 the character of his trouble changed, and he now began to have pain in the pit of his stomach, which appeared at regular intervals after meals. In the beginning of 1914 he had five attacks of what was diagnosed appendicitis, and he was sent home for operation in July of the same year. Laparotomy was performed the following August and a diseased appendix removed, but he stated that it was impossible to explore the rest of his abdomen as he took the anæsthetic badly. In November of the same year he had another attack of his epigastric pain, which continued at intervals to bother him, and resisted medical treatment until April, 1915, when he underwent an operation for duodenal ulcer, the ulcer being invaginated and a posterior gastro-enterostomy performed. This gave him relief, apparently for a few weeks only, when he began to suffer from pain all over his abdomen, and loss of appetite. Up until 1917 he continued in ill-health, having frequent attacks of pain, referred mainly to his left upper abdomen. Latterly he had been troubled with constipation, and as this was thought to be the main cause of his condition, he underwent treatment for it, with decided improvement, and during 1918, although he was better than he had been for some years, he described himself as 'nothing very grand'. About Christmas of this year he began to suffer from what he called gastritis, the symptoms being pain, increasing in severity until he vomited, after which he got relief. The vomitus was often brown in colour, but it is uncertain whether it contained blood. Under treatment he improved considerably, and in November of the same year went back to East Africa, where he remained well until April, 1920. He now developed diarrhœa, and on May 9 he vomited stercoraceous material, which was repeated at varying intervals until October 9.

At this point he was seen by me at Duff House in consultation with Dr. Spriggs, where he had been for a short time under treatment. The following is an excerpt of Dr. Spriggs' notes of the case :—

Examination.—Height 6 ft. 3 in., weight (in dressing gown), 10 st. 8¾ lb. Cardiovascular, blood, and nervous systems normal ; Tongue clean, with small patches of denuded epithelium near the tip. Teeth adequate. Abdomen : Slight fullness in left hypochondrium ; no tenderness or rigidity.

Gastric Contents.—Test breakfast : Free HCl present ; Total acidity 67 ; Metallic chlorides 0·16 per cent ; Active chlorides 0·26 per cent, i.e., slightly hyperacid. Vomit : Acid, brick-coloured mass with fæcal odour.

X-ray Examination.—Abdominal opacities negative. Stomach contracted 2 inches above stoma through which material rushes during ingestion ; emptied in 2½ hours. Pylorus not seen normally filled. No ileal stasis. Cæcum and colon dilated, and expel contents rapidly. Barium enema : Rectum and sigmoid normally filled ; rest of colon irregularly segmented. No material was seen to enter the colon from the stomach, or vice versa.

Fæces.—Liquid or pultaceous clay-coloured motions ; 3 to 6 in twenty-four hours ; total weight 700 to 1200 grms. ; many fatty-acid crystals and some undigested meat fragments. Culture : *B. coli* only ; no protozoa.

Urine.—Nil abnormal.

Result of Analysis of Urine and Fæces during 3 Days, Aug. 10, 11, and 12, 1920, on Diet A. 3.
Total weight before drying—4350 grms. Water 94·0 per cent.

	Nitrogen	Carbohydrate	Fat
Actual weight per diem in food ..	14·42	190·1	108·3
„ „ „ „ fæces ..	1·98	—	33·2
Percentage in dried fæces	2·3	trace	38·0
Percentage absorbed	—	100	69·3

Of the total fat, 38·1 per cent was neutral, 47·3 per cent fatty acids, and 14·6 per cent soaps.

Nitrogen in food		14·42 grms.
„ „ urine ..	13·53 grms.	
„ „ fæces ..	1·90 „	15·43 „
	i.e., a minus balance of	1·01 „

Diastatic value of urine 45 (normal 10 to 20). Tryptic value of fæces 10 (normal 25), fæces very dilute.

A provisional diagnosis of sprue complicated by the regurgitation of fæcal material into the stomach, had been made, but treatment for the condition had proved unsatisfactory. That there was some communication between the intestine and the stomach other than that of the gastro-enterostomy was clear from the following facts: during the attacks of fæcal vomiting the vomitus was indistinguishable from what came per anum; moreover, between attacks he was constantly having foul eructations; and lastly, when an attempt had been made to wash out his colon, he vomited part of the fluid injected. The most likely explanation of the condition was the formation of a gastrocolic fistula, and operation was recommended.

Operation.—On the morning of operation his stomach was washed out, but the whole of the fluid was not returned. He informed the nurse that on previous occasions when he had washed out his stomach he had had a similar experience, and that when the fluid was not all returned, it made his bowels move. On opening the abdomen and examining the site of the posterior gastro-enterostomy, the jejunum was found adherent to the under surface of the transverse colon immediately adjacent to the site of the stoma. The latter was ample and well placed. The jejunum was separated from the stomach and colon, and it was found that the gastro-enterostomy opening in the stomach lay side-by-side with an opening the size of a two-shilling piece in the colon, and that both these communicated with a common opening in the jejunum. As the pylorus was not contracted, and there was now no trace of duodenal ulcer, the gastric, colic, and jejunal openings were closed separately. A very noticeable feature was the dilatation of the jejunum for a considerable distance below the site of the anastomosis. It was almost as large as the colon.

He made an uneventful recovery, and in due course returned to Duff House. On Nov. 19 Dr. Spriggs reports the result of the absorption test on a three days' measured diet, as follows: "It shows that 96 per cent of his fat was absorbed and on nitrogen balance in the three days put on 3·5 grammes N; so that these figures are normal. The acidity of the stomach was raised. A test breakfast gave an acidity of 86, with active chlorides 0·21 per cent—this is a little on the high side". On Nov. 29 the patient reports that he weighs well over 12 stones, and that although he has been suffering a little from hyperacidity, he is gradually getting better from it.

Remarks.—The development of the peptic ulcer, which was jejunal in type, took place probably within the first two years after gastro-enterostomy was performed, in all likelihood when he began to locate his pain in the left upper abdomen. That the hyperacidity had a causal relation to it seems clear, although I am told that an unabsorbable suture had been employed: no trace of it could be discovered at the operation. The onset of diarrhœa in April, 1920, followed in May by stercoraceous vomiting, settles without much doubt the date of perforation. As regards the future, treatment must be directed towards reducing the hyperacidity.

INSTRUCTIVE MISTAKES.

GALL-STONE WITH PERFORATIVE CHOLECYSTITIS SIMULATING ACUTE APPENDICITIS.

The patient, a soldier, age 18, was admitted to a base hospital in France complaining of abdominal pain and vomiting. He said that he had been in another base hospital six weeks before with appendicitis. No operation was done, and he remained in hospital for ten days, subsequently going to a convalescent camp and his base depôt, having again become ill twenty-four hours before admission.

On Admission his temperature was 103°; pulse 120; tongue dry and furred. His abdomen moved badly on respiration. There was tenderness and great rigidity in the right iliac fossa, but the upper half of the right rectus muscle was also somewhat tender and rigid, though less so than the lower half. Signs of free fluid were obtained in both flanks.

The patient complained of pain on micturition, and was tender per rectum high up on the right. A diagnosis of acute appendicitis with peritonitis was made, and the abdomen was opened by a right rectus incision. The appendix was found to be normal in appearance except for a little superficial redness which it shared with the neighbouring viscera. Free colourless fluid was found in the peritoneal cavity. On further examination a lump was felt in the region of the gall-bladder. The incision was extended upwards, and after separating the omentum which enveloped it, a thick-walled gall-bladder, containing one large stone in the neck, was found, with a perforation about half-way down the fundus. The gall-bladder and stone were removed. Cultures from the free fluid and contents of the gall-bladder gave a pure growth of *B. paratyphosus B.* The patient made an uneventful recovery.

On reviewing the symptoms, the only ones which were not quite in accordance with the diagnosis made were the tenderness and rigidity of the upper part of the rectus, and the temperature, which was rather high for appendicitis. The patient stated that previous to his first admission to hospital he had never had a day's illness. A leucocyte count was not made.

GALL-STONES AND ACUTE PANCREATITIS SIMULATING PERFORATED GASTRIC ULCER.

A woman, age 44, was admitted to hospital with the history that, two days before, she was seized with sudden acute pain in the upper part of the abdomen. During the two days she had vomited at frequent intervals dark-yellow watery vomit. She was constipated, and had passed one black stool since the onset of the pain. She had suffered with 'indigestion' for years.

On Admission her temperature was 100°; pulse 88; respirations 52. No abnormal signs in chest. Abdomen generally tender, of 'board-like' rigidity, especially in epigastrium; did not move on respiration. Liver dullness present; shifting dullness in flanks. Complained during examination of intermittent 'colicky' pains, and especially of pain in the small of the back.

Laparotomy was performed. Free fluid, pale yellow in colour, was at once seen.

The great omentum and mesocolon were œdematous and bile-stained. One small lobule of fat in the omentum showed fat necrosis. The head and about one inch of the body of the pancreas formed a hard mass three times the size of the normal gland. The gall-bladder was distended with bile and contained twenty-seven gall-stones. These were removed together with the gall-bladder; the pancreas was incised and a drainage tube inserted down to it. After mopping out the abdominal cavity, the abdomen was closed.

The urine, which was drawn off by catheter at the end of the operation, contained bile; sugar was absent, but 200 units of diastase were present. The urine next day contained 100 units of diastase and a little sugar; three weeks later the diastase had fallen to 10 units, and no sugar was found. Loewe's adrenalin test at no time caused mydriasis. No cyanosis was observed at any time.

On reviewing the symptoms, the persistent pain in the back, the abdominal rigidity for forty-eight hours after the onset of 'perforation', the undiminished liver dullness, and the pulse of 88 after the same lapse of time, are points against the diagnosis of perforated gastric ulcer. An examination of the urine would probably have given the clue. As it was, the patient was caught in the pre-hæmorrhagic stage of acute pancreatitis and made a perfect recovery.

AN OVARIAN CYST DIAGNOSED AS A NEW GROWTH OF THE COLON.

A WOMAN, age 52, complained of constipation, pain, and swelling of the abdomen. Neither abdominal, vaginal, nor rectal examination revealed anything. A provisional diagnosis of a pelvic tumour was abandoned, because the pelvis was empty and the normal uterus could be felt. The presence of a little blood on the examining finger in the rectum suggested a carcinoma of the descending colon. An exploratory laparotomy was advised and refused. Three months later the woman presented herself again on account of increasing abdominal pain, swelling, and constipation; and now three ill-defined lumpy swellings could be felt towards the upper part of the abdomen; the bowels were constipated, and only relieved by enemata. There had been no signs of rectal bleeding and no loss of weight.

The diagnosis made was carcinoma of some part of the colon, with secondary deposits in the mesentery and omentum, and commencing intestinal obstruction.

Laparotomy was advised with the idea of relieving impending intestinal obstruction by short-circuit. On opening the abdomen a large multilocular ovarian cyst with a long stretched-out pedicle was found. The cyst lay high up in the abdomen, and was adherent to coils of intestine. The cyst was removed, and recovery was uninterrupted.

SHORT NOTES OF RARE OR OBSCURE CASES.

PERFORATION OF THE URETER BY CALCULUS: EXTRAVASATION OF URINE: DEATH FROM URÆMIA AND SEPSIS.

By JAMES BERRY, London.

James P., age 21, carman, was first seen by me at the Royal Free Hospital on the evening of March 13, 1919, on account of a painful swelling of the right iliac fossa. For the previous nine weeks he had had a dull aching pain on the right side of the abdomen, and on the morning of March 12 he noticed a lump in the right groin. A few hours later he was seized with severe pain in the same region, and he vomited once. In the evening he was brought to the hospital and admitted. In the right inguinal region was a small soft swelling which was supposed to be a hernia; it was easily reduced shortly after admission, and the case was not thought to require any immediate operative interference. Temperature 99·6°, pulse 80, respirations 24. There was some rigidity and tenderness over the whole of the right side of the abdomen. An examination of the rectum was made, and it was reported that nothing abnormal could be felt. The urine was clear and acid, and said to contain no abnormal constituents. The patient was drowsy and unable to give a very clear account of his symptoms.

On the following day he seemed worse, the abdomen became distended, and the rigidity and tenderness on the right side increased. Temperature 100°, pulse 102. At 6 p.m., when I saw him, he was obviously very ill. There was no evidence of any hernia, but there was an ill-defined fullness in the right iliac fossa, without any marked tenderness on pressure; there was considerable general abdominal swelling, and definite rigidity of the right rectus. There was also some dullness in the iliac fossæ and hypogastrium. It was noticeable that the patient was thin and undersized, and looked much more like a boy of 15 or 16 than a man of 21.

No definite diagnosis could be made, but the patient was sent at once to the theatre, and the right iliac fossa explored through an oblique incision. On opening the peritoneal cavity a pint or more of clear, colourless, and odourless free fluid escaped. The appendix, intestines, and gall-bladder were all found to be normal. The right kidney was felt to be enlarged and flabby. It was then noticed that there was some swelling of the retroperitoneal tissue in the right iliac fossa, and in this swelling, near the brim of the pelvis, a small hard body could be felt. The patient was then put in the Trendelenburg position, an incision was made into the retroperitoneal tissues, and the hard body, which proved to be a calculus lying close to the ureter, was removed. In the right ureter, at the brim of the pelvis, was a ragged hole about half an inch in length, through which the calculus had evidently escaped. The ureter itself was much dilated and thickened; a probe was passed downwards into the bladder, and no other stone was felt. The œdema of the retroperitoneal tissue in the iliac fossa was clearly due to extravasated urine. As it was obviously impossible to sew up the ragged opening in the ureter, one end of a small rubber tube was placed in it, and the other end brought out through the abdominal wound, a second tube being placed in the abdominal cavity for drainage.

Subsequent Progress.—The peritoneal drain was removed on the day after the operation, the ureteric drain on the seventh day. The average daily amount of urine passed,

partly through the tube and partly per urethram, was between $3\frac{1}{2}$ and $4\frac{1}{2}$ pints. The specific gravity varied from 1008 to 1010, and there was nearly always a trace of albumin and a good deal of pus, and sometimes a little blood. For about a week the patient seemed to be doing fairly well; then he began to get more and more drowsy, and he finally died of uræmia and sepsis on April 6, twenty-four days after the operation.

Post-mortem Examination.—This brought to light the condition shown in the accompanying drawing (*Fig.* 238), namely, double suppurative pyelonephrosis, with much destruction of the renal tissue. A second and much larger calculus was found impacted in the lower end of the left ureter. Both ureters, but especially the left, were greatly dilated, and the cellular tissue in the right iliac fossa and round the lower end of the right ureter was in a state of diffuse suppuration. The lungs showed bronchopneumonia. There

FIG. 238.—Double suppurating pyelonephrosis ($\frac{1}{3}$ scale).

was no peritonitis. The stones and urinary organs are now in the Royal Free Hospital Museum.

Remarks.—It is evident that both stones must have been lying quietly in the ureters for many years without causing any marked symptoms, although gradual and extensive destruction of the kidney tissue had been produced by pressure atrophy. The perforation of the right ureter and consequent extravasation of urine took place presumably on the day preceding the operation, when acute pain was first noticed.

It is to be regretted that no *x*-ray examination was made at any time. Had this been done years ago, the true nature of the case would have been revealed, and an operation for the removal of the stones, before the kidneys became distended and atrophied, would have been a comparatively easy affair, and would doubtless have saved the patient's life.

It is probable that before the operation the stone was only partially extruded from the ureter, and that the complete extrusion occurred only during the manipulations at the time of operation.

Finally, there can be but little doubt that the ill-development and juvenility of the patient was associated with the long-continued and progressive atrophy of the kidneys.

PAPILLOMA OF THE BLADDER OF UNUSUAL SIZE.

By JAMES BERRY, London.

George P., age 34, ironmonger's assistant, married, was sent to me at the Royal Free Hospital on Jan. 19, 1914, by Dr. Giuseppi, of Felixstowe, with the diagnosis of papilloma of the bladder. For eighteen months the patient had had gradually increasing intermittent hæmaturia, and recently micturition had become frequent and painful. He was a thin, pale man, but otherwise healthy. Cystoscopic examination showed a typical villous papilloma near the orifice of the *left* ureter, and washing of the bladder yielded small pieces of soft growth which confirmed the diagnosis. On Jan. 26, 1914, the bladder was opened suprapubically, and the growth, which was about as large as a walnut, was freely removed with scissors, together with its narrow pedicle and its base, the wound in the mucous membrane being sewn up with catgut. *The rest of the bladder was examined for other papillomata, but none were found.* The upper part of the cystotomy wound was closed with catgut sutures; the lower part was drained with a rubber tube for four days. Recovery was uneventful, and the patient returned to his home in the country on Feb. 21, the wound being soundly healed. He was advised to return if further hæmorrhage should occur.

For three years he remained quite well, and then began to have a recurrence of the hæmaturia, at first at intervals of about four to six weeks. In July, 1919, micturition began to be painful, and eventually his symptoms became so severe that in October he again consulted Dr. Giuseppi, who sent him back to me at once.

On admission, Oct. 22, he was in a miserable condition, passing water about every twenty minutes during the daytime and several times at night. The urine, which was faintly alkaline, and of sp. gr. 1015, contained blood and triple phosphates. The hæmaturia prevented any satisfactory examination with a cystoscope.

After a few days' preliminary treatment to diminish the alkalinity of the urine, the bladder was opened a second time on Oct. 27, and was found to be practically filled with soft papillomatous growth. This was rapidly pulled out of the bladder, partly with fingers and partly with scoop, until the bladder was nearly empty and the pedicle could be seen. This was about as thick as a little finger and sprang from the *right* side of the fundus of the bladder near the posterior wall, at a point about 1½ in. behind and above the right ureteric orifice. The pedicle was drawn forward, and its base, including some of the muscular wall of the bladder, excised freely with scissors. The wound thus made was sewn up with deep interrupted catgut sutures. A careful examination of the interior of the bladder showed that there were no other papillomata anywhere. The site of the previous papilloma was quite free from recurrence. The cystotomy wound was treated, as before, by partial suture and drainage for a few days. The patient again made a rapid recovery, and left the hospital nineteen days after the operation, quite well, and with the wound soundly healed.

About seven months later he came up again to report that he was quite well and had had no return of his symptoms.

Pathological Report.—The tumour removed at the second operation weighed 8¼ oz., and proved to be a simple villous papilloma of the usual type, springing from a single slender pedicle (*Fig.* 239). Microscopic sections, both of the tumour itself and of the portion of excised bladder wall, were made by Dr. Mary Schofield, Assistant Pathologist to the Royal Free Hospital, and show no evidence of malignancy.

Prof. Shattock has been good enough also to examine the sections with me, and has sent the following note: "Microscopic sections, carried through the tumour so as to include its slender pedicle, show that it is a simple villous papilloma, constructed of fine and highly vascular branching processes covered with transitional epithelium. The 'core' of the growth at the site of the pedicle consists of common connective tissue abundantly supplied with vessels, and includes a certain amount of unstriped muscle. The size and compactness of the bundles at the actual line of division indicates that here they represent portions of the proper muscular wall of the bladder; but beyond this the bundles become very slender and widely scattered in the connective tissue of the deeper portions of the processes, and may here be referred to the muscularis mucosæ."

FIG. 239.—Villous papilloma of the bladder, weighing 8¼ oz.

The tumour and microscopic section are now in the Museum of the Royal College of Surgeons.

Remarks. — The chief points of interest about the case are the very large size of the second tumour, and the fact that it is known to have grown to this size in a period of not more than five and a half years at the outside. The next largest innocent papilloma of the bladder which I have seen is in St. Thomas's Hospital Museum, and weighs 4 oz., which is less than half the weight of this one.

A CASE OF TONSILLAR CALCULUS OF UNUSUAL SIZE.

BY G. S. WOODMAN, KIRKUK, MESOPOTAMIA.

THE somewhat rare occurrence of large calculi in the tonsils has induced me to publish the notes of the following case which I saw at Kirkuk, in Northern Mesopotamia.

A. B., an ex-Turkish official, age 64, came to see me in 1919, complaining of the presence of 'a stone in his mouth' which caused difficulty in swallowing. He gave the following history. Thirteen years ago he had a stone about the size of a large pea in the right side of his throat, accompanied by an abscess in the upper part of the right side of his neck. The latter burst spontaneously, and the resultant sinus healed after removal of the stone per os. About three years ago a painless swelling appeared in the same site as the abscess referred to. This he poulticed with dried Smyrna figs; pus formed, and the swelling was incised by a German doctor in Stamboul. The wound took a long time to heal, and has since frequently broken down and discharged a small

quantity of thin sero-pus. The patient also stated that he imagined liquids escaped from the sinus on swallowing.

On examination, a stone was seen lying between the pillars of the fauces on the right side and firmly gripped by them, presenting an exposed surface about the size of a sixpence. Externally, in the upper part of the right anterior triangle of the neck, there was a small sinus which admitted the probe to the extent of a quarter of an inch. The stone could not be felt with the probe, and there was no evidence of any septic focus in the mouth or throat.

I extracted the stone with bullet forceps, considerable force being required. During removal the anterior pillar of the fauces was torn, the calculus being much broader at its centre than at the presenting surface. The accompanying illustrations (*Figs.* 240, 241), which are three-quarters natural size, show this point The weight of the calculus (which

FIGS. 240, 241.—Tonsillar calculus (¾ natural size), with skiagram.

is now in the Museum of the University of Durham College of Medicine) was 3½ drachms. Professor P. Phillips Bedson, who kindly examined it, reports that it is composed of phosphates and carbonates of lime, which accounts for its extreme opacity to *x* rays.

My opportunities of access to records of similar cases are limited. Bryant[1] reported a case of "calculus from the tonsil of the size of a small nut, spontaneously ejected", which he considered the result of calcification of a tuberculous deposit, around which suppuration had occurred, leading to its ejection. The specimen under notice would appear to be the result of long-continued suppuration.

Since my return to Kirkuk I have examined the late owner of the stone, and find that the old sinus in the neck has remained healed; there is nothing abnormal to be noticed in his fauces; a palpable thickening of the deep tissues is all that remains.

I wish to thank the Secretary for Health to the Civil Commissioner in Mesopotamia for permission to publish these notes.

REFERENCE.

[1] *Lancet*, 1860, ii.

A CONGENITAL ABNORMALITY OF THE FEMALE GENITO-URINARY ORGANS.

By HAROLD BURROWS, Southsea.

The following case of congenital defect has some features which seem to render it worthy of record :—Miss B., a girl of 21, had become engaged to be married. She was sent to me by Dr. Mabel Ross, because she had never menstruated and it was thought that perhaps an operation might put things right. The patient was a healthy, bright, attractive-looking girl, and perfectly feminine.

On examination the mammæ and external genitalia were found to be normal in appearance ; there was, however, no vaginal opening, nor did a rectal examination detect the presence of either a vagina or a cervix uteri ; there seemed to be but a thin partition between the rectum and the bladder. On abdominal palpation a rounded swelling was found occupying the left half of the pelvis, to the wall of which it was fixed. The girl had felt no pain in this lump, nor had she experienced any menstrual molimina. I thought the lump probably was a hæmatometra which had become adherent to the wall of the pelvis through some inflammatory process ; and with this view I advised her to have an operation done, to which she consented.

Operation.—A short transverse incision was made in the perineum, and the bladder was separated from the rectum for as great a distance as was possible through this route, but no trace of a vagina or a cervix uteri could be found. The wound was closed, and the abdomen was then opened by a median subumbilical incision, when the following abnormalities were discovered :—

There was a total absence of the vagina, uterus, broad ligament, right Fallopian tube, right ovary, and right kidney (no search was made for the right ureter). In the left loin was a very small kidney, but it did not feel like an active one ; in fact it seemed to be merely vestigial. Attached to the left brim of the pelvis was a sessile, cylindrical ovary which was clearly functioning. A Fallopian tube was present, and appeared to be normal at its fimbriated end where it was close to the ovary, but the tube itself dwindled away and disappeared at the upper pole of the pelvic lump which had been felt on abdominal palpation previous to the operation. The tube was closely applied to the peritoneum over this lump, and had no mesentery.

The pelvic tumour was next examined, and was found to be extraperitoneal. The peritoneum was incised over the swelling, and was easily stripped away from it. The swelling itself was roughly globular in shape and slightly lobulated, its substance having the appearance of that of a healthy kidney. A small portion was removed for microscopical examination, and was later found to consist of normal renal tissue. The bladder, rectum, and other viscera revealed no abnormality. No further examinations were made, though a cystoscopic inspection would have been of interest.

The case is not easy of interpretation. For if we assume that the right Wolffian body had failed to develop, it is difficult to explain either the presence of the two kidneys on the left side, or the atrophic condition of the left kidney. And if on the other hand we suppose that some abnormal gubernacular action or other mechanism had pulled the whole right Wolffian apparatus down into the left side of the pelvis, why should there be no discoverable trace of a uterus or vagina ?

Interesting features are the perfect mental and bodily health of the patient, and the retention in a complete degree of the feminine characteristics.

TWO CASES OF INTESTINAL OBSTRUCTION DUE TO AN ENTEROLITH; WITH REPORTS OF THE CHEMICAL ANALYSIS.

By JAMES PHILLIPS, Bradford.

On Jan. 22, 1920, I saw with Dr. Jenkins, of Shipley, a woman, age 65, who, after two or three months of increasing constipation, had been seized with rather severe abdominal pain four days previously, and who, when I saw her, was vomiting what was described as fæcal-smelling fluid. There had been no proper action of the bowels for four days. The same evening I opened the abdomen at the Bradford Royal Infirmary, and at once came on stinking pus. Near the cæcum I felt a hard body in a coil of bowel, and on delivering the latter saw that it was ileum near its lower end, and that the mesentery was gangrenous, with foul intestinal contents oozing from the gangrenous patches. I put a Paul's tube into the delivered coil of bowel and drained the abdomen, but the patient was desperately ill, and died thirty hours later.

The stone, which was removed, was rather larger than a big walnut, and I diagnosed the case as one of obstruction by gall-stone. But, post mortem, the R.S.O., Mr. Stewart, examined the abdomen and found that the gall-bladder was free and apparently normal. I then cut across the stone and found that it was formed of concentric layers of cocoa-brown material of the consistence of a gall-stone but gritty on section, and that its core consisted of a plum-stone.

Mr. Richardson, the Bradford City Analyst, kindly made a chemical analysis of the stone, of which the following is a summary :—

Moisture	2·6	per cent
Ash	less than 0·1	per cent (calcium compounds)

Analysis of dry organic matter :—

Carbon	71·17	per cent
Hydrogen	10·87	,,
Nitrogen	0·29	,,
Sulphur	0·39	,,
Oxygen	17·26	,,

The probable presence of taurocholic acid, $C_{26}H_{45}O_7NS$, would account for the presence of nitrogen and sulphur. The concretion was sparingly soluble in hot benzene, but more soluble in a mixture of equal parts benzene and alcohol. The portion soluble in the alcohol and benzene mixture contained free acids which were estimated by titration. By saponification with alcoholic potash the fatty complex was found to consist of oxy-fatty-acid esters and anhydrides. A small amount of unsaponifiable substance melting at 99° C. was also obtained. The purified oxy-fatty acid melted at about 102° C. A rough outline analysis of the concretion would be as follows :—

Oxy-fatty acids	free	25·3	per cent
	as glycerides	14·0	,,
	as anhydrides	28·0	,,
Unsaponifiable substance		3·0	,,
Taurocholic acid		6·0	,,
Hyperoxidized insoluble matter		23·6	,,
Mineral matter		0·1	,,
		100·0	

On May 12, 1920, I saw with Dr. Viret a woman, age 68, who had suffered from abdominal pain, vomiting, and obstinate constipation for four weeks. There had not been complete obstruction of the bowels, and there had been days when there was very little pain or vomiting; but she had been able to keep little or nothing on her stomach, had lost much weight and strength, and had slept little. The vomit was described as "mostly bile-coloured and having a very nasty taste". There were no localizing signs and no distention. I opened her abdomen on the same evening and felt a foreign body which, when delivered, was found to lie in a coil of small gut—

apparently about the middle of the jejunum. It was removed by enterotomy and the abdomen closed; but the patient died without recovering consciousness.

The stone was of similar size and shape to the other, of rather lighter colour, of similar consistence but of looser texture, so that the layers crumbled when an attempt was made to section it.

Professor Raper, of Leeds University, kindly examined it for me. He tells me he has not been able to find any similar case recorded, and he proposes shortly to publish a fuller account of the examination of the enterolith in the *Biochemical Journal*; appended is a summary of his report:—

The weight of calculus as received was 6·8 grms. It was friable in texture and of a sandy colour, but had no definite nucleus. On grinding to powder, two small flat pieces of tissue resembling fruit-skin were obtained; otherwise it appeared to be homogeneous in structure.

By extraction with solvents three main fractions were separated: (1) Fatty substances, consisting of free fatty acids, neutral fat, and cholesterin, etc. This formed 16·4 per cent of the whole. (2) Unconjugated bile acids, almost wholly choleic acid. This formed 7·25 per cent of the whole. (3) This was insoluble in water and ordinary organic solvents, and consisted of food residues, bile pigment, etc. It formed 8·4 per cent of the whole.

Two-thirds of fraction (1) consisted of free fatty acids with an iodine value of 45·8. From fraction (2) choleic acid was obtained practically pure by one recrystallization. A small amount of an acid resembling dioxycholic acid was obtained from the mother liquors.

The mere trace of cholesterin found indicates that the calculus was not formed in the gall-bladder, and this is supported by the fact that the bile acid in the calculus was choleic and not glycocholeic acid. The latter has been found in human bile, but not the former. The reason for the deposition of choleic acid in the intestine is obscure, but the great insolubility of this acid compared with cholalic acid probably accounts for the presence of one only, and that the more insoluble one.

Remarks.—The chief interest of these two cases lies in the evidence they offer of the probability that in some of the cases described as 'intestinal obstruction by gall-stones' the cause of the obstruction may have been an enterolith.

I have seen in the last twenty years perhaps eight to ten such cases: in all of them the obstructing body was of size and shape similar to the two enteroliths above described —which I need hardly say is not the usual size of a gall-stone. In my first case it was only Mr. Stewart's discovery that the gall-bladder appeared normal which led me to divide the stone, and even then, had its nucleus not been so obvious a thing as a plum-stone, its appearance was sufficiently like a gall-stone to make it doubtful whether it would have occurred to me to have it analyzed. In the second case there was a nucleus of two small pieces—probably of fruit skin—but these only became apparent when the stone had been ground to powder.

In Moynihan's text-book on gall-stones (p. 253) is the description of a case by Lynn-Thomas. A man had died of intestinal obstruction. No operation had been performed. "The stone is remarkable as being conico-cylindrical in shape, like a pom-pom shell; it is $1\frac{5}{8}$ in. in diameter, and its point had travelled in front. *There were no adhesions around the gall-bladder and bile-duct.*" In other words, the stone was presumed to be a gall-stone from its naked-eye appearance.

My suggestion is that in such cases chemical analysis of the stones should be made; my feeling is that not a few stones which look like gall-stones would be found to be enteroliths. Professor Raper will be very glad to examine any specimens which may be sent to him.

REVIEWS AND NOTICES OF BOOKS.

Surgery, a Text-book by Various Authors. Edited by GEORGE E. GASK, C.M.G., D.S.O., F.R.C.S. and HAROLD W. WILSON, M.S., M.B., F.R.C.S. Roy. 8vo. Pp. xviii + 1232, with 39 plates (20 in colour) and 467 other illustrations. 1920. London: J. & A. Churchill. 42s. net.

THIS book, which is the evolutionary descendant of other text-books emanating from St. Bartholomew's Hospital, viz., Walsham's and then Spencer and Gask's Surgeries, is a notable addition to our surgical literature; this not so much on account of its good arrangement or its very beautiful illustrations, but because it represents the teaching of a single school of men who form the working team of one of our most ancient hospitals. Every member of the surgical staff and of all the special surgical departments of 'Bart's' has contributed to this volume. By this means, the advantages of getting articles by many authors and of preserving nevertheless a unity of conception and principles are both secured.

The main object of the book is a presentation of the practice, rather than the theory, of surgery, and this object is admirably fulfilled in the text, though it is to be noted that the illustrations in the main deal with pathology rather than with treatment of surgical disease. The practice of surgery described is that actually followed in the wards and out-patient clinics of St. Bartholomew's Hospital, and references to other surgical teaching are necessarily much curtailed. The inclusion of the whole practice of surgery in a single volume has necessitated articles on the eye, ear, nose, throat, and female genital organs, some of which are not complete enough even for the student's purpose, whilst the sections dealing with general surgery are shorter than their importance demands. The omission of a section on anæsthetics is unfortunate, and we are given the impression that the methods of local, spinal, intratracheal, or gas-and-oxygen anæsthesia hold no place in the practice of the hospital.

The descriptive illustrations of diseases and of diseased tissues form one of the most striking features of the work, the majority of the specimens presented being from the museum of the hospital. This pre-eminence of the pathological aspect of surgical teaching is very appropriate in a work emanating from the school to which Paget belonged.

In the matter of surgical methods of treatment the book is conspicuously moderate, even at the risk of being old-fashioned. This is seen, for example, in the section on fractures, and also in that on abdominal surgery. In fracture treatment open operation is relegated to such a subordinate place that no idea of methods or technique is obtained. Both in the fractured femur and in Pott's fracture, immobilization of the joints is taught as the routine method. In the treatment of hernias trusses play a very conspicuous part, even in such cases as irreducible femoral hernia. The radical operation for femoral hernia makes no mention of the part played by the conjoined tendon. In the section dealing with the stomach, excision of the ulcer-bearing area is not considered in relation to pyloric ulcers; and when partial gastrectomy is described for pyloric cancer, the suture of the whole open end of the proximal portion of the stomach into the jejunum finds no place.

The Early History of Surgery in Great Britain: its Organization and Development. By GEORGE PARKER, M.A., M.D., M.R.C.S. 8vo. Pp. ix + 204. Illustrated. 1920. London: A. & C. Black, Ltd. 7s. 6d. net.

THE history of their art has never appealed very much to surgeons. Ostensibly because they are more inclined to look forward than backward, or because they are too busy to trouble about the past; in reality because the majority are deficient in general education and have never made a study of the liberal arts and sciences. In this respect the Hunterian tradition is not yet dead, though he and his followers would have saved themselves a world of trouble and some bad mistakes had they known of the work done by their predecessors. The fault was not wholly theirs, for few books have been devoted wholly to the history of surgery, whilst those which existed were not always easy of access, were somewhat dull, and were often written in a language not understanded of the people. This excuse will no longer suffice. Dr. George Parker has written a primer of the history of surgery which is accurate, cheap, and interesting. He states modestly

that this volume is only an instalment of an inquiry into the ancient therapeutic gilds of this country—a subject upon which he is already a recognized authority. It is to be hoped, therefore, that Dr. Parker will continue to publish his results from time to time and not wait to issue them as a whole.

In the present work he begins his story about the year A.D. 1000, and ends it at 1850. It is remarkable how often aseptic methods were adopted by some of the greater surgeons who succeeded in obtaining union by first intention as a result of simple dressings and cleanliness. In every case their successors, and often their own pupils, fell back upon the salve surgery of Galen, until at last it became an axiom that every wound must suppurate before it could be healed *secundum artem*. Equally remarkable was the diagnostic and operative skill of these early surgeons, who would bring to a successful issue such operations as the suture of nerves, the repair of wounded bowel, and the removal of deeply-seated foreign bodies. As early as 1180 the Priory of Buckland Brewer, in Somerset, was devoted to the use of ladies and serving sisters of the Order of St. John of Jerusalem or the Knight Templars—says Dr. Parker—and this may be looked upon as the first training-school for nurses in England. Alluding to the English surgeons of this period, Dr. Parker might have given some of the facts which are known about Thomas de Weseham—the King's surgeon—which redeem him from the shadows of time which have enveloped all his contemporaries. Amongst other things, he was fortunate in obtaining a die which allowed him to mint his own money, and some silver pennies from his mint were found at Bruges a few years ago.

Dr. Parker gives an admirable account of the organization of surgery in England before 1540, and in London after 1540, and arrives at a remarkable generalization when he says, "There is some reason to think that Henry VIII, before he became involved in matrimonial troubles and ecclesiastical reforms, projected a complete reorganization both of medicine and surgery, and actually succeeded in carrying out a large part of his scheme". The hypothesis is fascinating, and it would be interesting to discover to what extent the King was the motive power behind Butts, Ferris, Vicary, and Harman. The growth of surgery in England after the Tudor period was very slow for nearly a century, and Dr. Parker states that it was no quicker abroad. But in the eighteenth century began the great revival of hospitals throughout the country that was the first sign of the coming humanitarian and social movement which is only just now expending itself—at any rate in the voluntary support of hospitals. Dr. Parker traces the rise of the hospitals and their schools, and also chronicles the failure of the gild authority, not only in London but throughout the kingdom. He concludes his survey with a tribute to the work done by the German and Viennese schools in the nineteenth century.

The book is illustrated with well-chosen and well-executed reproductions from various sources. There is a good index, and a most useful series of dates of the chief events in the history of surgery in the United Kingdom.

Orthopedic and Reconstructive Surgery, Industrial and Civilian. By FRED H. ALBEE, A.B., M.D., Sc.D., F.A.C.S., etc. Large 8vo. Pp. 1138, with 804 illustrations, including many coloured plates. 1919. Philadelphia and London: W. B. Saunders Co. £2 10s. net.

THIS important volume represents the author's well-known views on the subject of bone-grafting as applied to the whole realm of orthopædic and reconstructive surgery. Carefully written, profusely illustrated, and published according to Messrs. Saunders' high standard, it contains a very great wealth of material, and although probably no one will agree with all of its recommendations, yet there is no subject in which valuable and original contribution is not made to our knowledge of the technique and resources of bone surgery.

The chief value of the book consists in its presentations of new methods of treatment by means of bone-grafting. Its chief drawback is that the more conservative methods of treatment are described inadequately. This is seen most notably in the section dealing with tuberculous spine, in which disease the author holds that bone-grafting should be applied to all cases in which pain or muscle spasm demand it. He considers that the presence of septicæmia or a local pyogenic infection are the only contra-indications to its employment. Results in 532 cases of Pott's spinal disease treated by bone-grafting are given, and in these it is claimed that in 84 per cent the disease was arrested. No attempt is made to compare with these cases others treated by purely conservative measures.

In the treatment of many simple injuries the author allows himself to be carried away by his enthusiasm for his own inlay methods to such an extent that he describes most unnecessarily complex procedures. For example, a fracture of the patella is treated by the inlay of an I-shaped piece of the tibia, and a fracture of the ulna by a sliding graft which his own pictures show to be very inefficient (*Figs.* 364, 367).

However, these are small points, whereas the amount of valuable and original suggestion throughout the whole book is very great. The full lists of original papers at the end of each chapter go far to make up for the deficiency in description of the usually accepted methods of treatment.

Injuries of the Peripheral Nerves. By Henry S. Souttar, C.B.E., F.R.C.S. and Edward W. Twining, M.R.C.S. Large 8vo. Fully illustrated. Pp. xii + 152. 1920. Bristol: John Wright & Sons Ltd. 18s. 6d. net.

Perhaps no branch of the reconstructive surgery of the war has evoked so much enthusiasm amongst the workers in this field as the surgery of peripheral nerve injuries. In the short, concise monograph of Mr. Henry Souttar and Mr. Edward Twining the enthusiastic note is uppermost, and the authors have succeeded in conveying it to the reader. This book would appear to have been designed essentially for the guidance of the student or young surgeon, rather than as a thesis for consideration by experts, as it is written in a somewhat dogmatic fashion, and contains little or no discussion on controversial matters. The views put forward are personal ones, and are founded on a period of special experience in this type of war injury.

In discussing the pathology of nerve injuries, the authors insist on the primary nature of the injury in the majority of cases, and they consider that scar contraction or the growth of callus is rarely if ever responsible for the actual nerve lesion. Due homage is paid to the well-established work on the internal anatomy of nerve-trunks and its relationship to the mechanics of suture and regeneration; but the dictum that one-third of any nerve-trunk can be divided without producing permanent injury is quoted and emphasized without realizing that an adherence to this faith is incompatible with a strict conception of nerve topography.

In the section dealing with the operative repair of nerve injuries, some of the details of technique and procedure recommended cannot be passed without criticism. The writers advise that, in performing nerve suture, the cut ends are to be pressed firmly together by means of a tightly-drawn tension suture. It has been shown conclusively that this manœuvre is an abuse of the otherwise harmless tension suture, is provocative of intraneural scar tissue in its track, and moreover is directly antagonistic to the occurrence of rapid and accurate regeneration. For complete lesions with extensive gaps, the authors duly emphasize the comparative ease with which most of these gaps can be bridged after extensive freeing of nerve-trunks combined with displacement. They do not condemn the use of free nerve-grafts in a whole-hearted fashion, as they consider that recoveries have been seen after the use of autogenous grafts. In this connexion it is unfortunate that no authorities are quoted, nor are any reports of successful cases included.

For true irreparable lesions the writers advocate bone shortening (in the upper limb only), the bulb-flap operation, or nerve anastomosis. All these procedures are illustrated, and constitute the sole illustrations dealing with the actual operative repair of nerve lesions. They are thus accorded a place of honour, and will inevitably acquire a certain degree of prestige as legitimate operations. We feel there is no justification either for their inclusion or condonation in an authoritative work.

The chapter dealing with the surgical anatomy of the individual nerves and the methods of exposure is excellent. For adequate exploration of the brachial plexus, division of the clavicle is considered to be necessary as a routine; this advice will be subscribed to by all surgeons who have had experience in this field.

The pre-operative preparation of the limb, and the post-operative treatment by the various standardized methods of physiotherapy, are dealt with in a convincing and lucid way. The authors do not include the end-results of the peripheral nerve operations carried out in their own services, but a résumé of the type of result to be expected in each particular nerve is presented. In discussing alternative operations for the restoration of function where direct nerve repair is impracticable or has failed, the common error of recommending a position of nearly 90° abduction in arthrodesis of the shoulder-joint is made. Ankylosis of the shoulder-joint in this degree of abduction is of course applicable only in the case of children. Further, the operation of choice for producing stability of the ankle-joint is not arthrodesis, but tendon fixation.

This book, with its attractive style and its marginally-placed headings of the various sections in each chapter, is singularly easy to read. From a teaching standpoint it is a valuable contribution to the subject of peripheral nerve injuries, but the dogmatic exposition of the methods of operative repair detracts from what is otherwise a well-balanced essay.

Chirurgie Réparatrice et Orthopédique. By E. Jeanbrau (Montpellier), P. Nové-Josserand (Lyon), L. Ombrédanne (Paris), and P. Desfosses (Paris). Large 8vo. Two volumes. Pp. 1340, with 1040 figures. 1920. Paris: Masson & Cie. 80 fr.

This work, in which forty-eight eminent French surgeons have collaborated, is a careful presentation of surgical practice such as may be demanded by the accidents and emergencies of civil life. It represents all the surgical lessons learned from the late war, but, instead of being merely a war surgery of retrospective interest, it is a practical application of lessons learned in the war to the kindred problems of peace.

The possibilities of surgical reconstruction after various injuries, the late functional results of the same, and the most suitable appliances which may be used to supplement or replace lost tissues or members, are the main objects of this work. The first part deals with general principles

both of surgical reconstruction and of the construction of apparatus. The second part shows the special application of these principles in the various regions of the body affected by injury—the head, neck, thorax, abdomen, and spine, as well as the limbs.

The work forms an invaluable book of reference, especially in regard to the construction of various types of apparatus which will assist in the restoration of function where full surgical repair is not possible.

The After-treatment of Surgical Patients. By Willard Bartlett, A.M., M.D., F.A.C.S., and Collaborators. Large 8vo, in two volumes. Vol. I, pp. xxii + 674; Vol. II, pp. xvi + 391; with 435 illustrations. 1920. London: Henry Kimpton. £3 net.

The author is one of the well-known and devoted band of American surgeons who, by their energy, have forced the attention of all British workers in similar fields to their meticulous and accurate investigations into those complications of surgical procedures, such for example as 'shock' (investigated by Crile), which have received comparatively scant attention elsewhere.

In these volumes the author has omitted the consideration of surgical procedures except in regard to certain minor operations such as blood transfusion, which is very fully dealt with. Surgical after-treatment has been considered as "beginning when the last suture is tied, and as lasting until the patient is restored to normal health".

The author advocates and carries out in his own clinic a 'follow-up' system which involves a correspondence with his patient for at least one year, and in certain kinds of cases, e.g., malignant, for many years. It is to be regretted that British surgeons are in the main so backward in this very important branch of after-treatment.

Vol. I deals with general subjects, Vol. II with measures of after-treatment as applied to operations on various organs. The author claims, and rightly, that works on general surgery give only scant attention to after-treatment.

Dr. Willard Bartlett has been remarkably fortunate in his choice of collaborators. The work of Dr. O. F. McKittrick on anæsthesia, pain, thirst, nausea and vomiting, etc., is particularly good, and much of it of real value. Dr. McKittrick's monographs on acid intoxication, diabetes in surgery, nephritis, etc., post-operative pneumonia, thrombophlebitis, and hæmophilia should be read by every surgeon. Dr. Ewerhardt contributes, amongst other chapters full of interest, those on exercise and massage, and hydrotherapy. A very excellent chapter is that on the post-operative treatment by radium and Röntgen rays in malignancy, by Russell H. Boggs.

Dr. Willard Bartlett on dry mouth, ether conjunctivitis, painful tongue, sore throat, etc., brings out many new theories as to their causation, and many hints, little known in this country, for their treatment. The author also deals in most lucid chapters with shock, hæmorrhage, post-operative ileus, artificial respiration, artificial nutrition, treatment of wounds, and re-amputations (the latter with Walter S. Priest).

Vol. II deals with the face and cranium, by Ellis Fischell; neck, thorax, abdomen, by Willard Bartlett; post-operative treatment of urological conditions, by John R. Caulk and Harry G. Greditzer; rectum and anus, by Francis Reder; obstetrics, by W. H. Vogt; and orthopædic work, by M. S. Henderson.

In nearly every case the writer has achieved a perfect monograph on his subject; almost every known theory is discussed and every known method of treatment indicated. The whole work reflects the very highest credit on Dr. Bartlett and on his choice of helpers. The opening chapter of the book by Dr. O. F. McKittrick on the "ideal post-operative room" will prove to those of us who operate in the usual English nursing home how far behind we are in this matter especially.

The printing, paper, and illustrations are of the best. One cannot too highly recommend the work.

Tumours Complicating Pregnancy, Labour, and the Puerperium. By Herbert R. Spencer, M.D., M.S., F.R.C.P. Pp. 78. Illustrated. 1920. London: Harrison & Sons. 5s. net.

This little book is a reprint of the Lettsomian Lectures delivered before the Medical Society of London in February and March, 1920. The chief feature of the lectures is the testimony they bear to the excellent consequences that have followed the intrusion of modern surgery into the stronghold of conservative midwifery.

The lectures are in the main an account of the lecturer's own experience and the methods he follows in the operative treatment of tumours complicating pregnancy. The most important section is that dealing with the treatment of cancer attacking the neck of the pregnant uterus.

The chief defect of these lectures, and a common one in gynæcological writings, is the long tables and tedious reports of cases that load the pages, and which few care to read or consult. In the opening lecture Dr. Spencer expresses his admiration for Horace, and he generously

presented to the library of the Medical Society a fine copy of the works of this poet, so that they may be consulted by the Fellows. Example is better than precept. Dr. Spencer on a future occasion will do well to follow the Horatian maxim expressed in the following lines :—

"Oh yes, believe me, you must draw your pen
Not once, not twice, but o'er and o'er again,
Through *cases and tables* if you'd entice ;
The man who reads you once to read you twice."

In this way the Lettsomian lecturer may

'Find audience fit, though few'.

Diagnosis and Treatment of Brain Injuries. By William Sharpe, M.D., Professor of Neurological Surgery, New York. Large 8vo. Pp. 757 ; 232 illustrations. 1920. Philadelphia and London : J. B. Lippincott Co. 35s. net.

The book is divided into three parts : (1) General considerations ; Pathology ; Diagnosis and Treatment ; Operative technique. (2) Brain injuries in adults : Illustrative cases, (*a*) acute, (*b*) chronic. (3) Brain injuries in newly-born babies and children : Illustrative cases, (*a*) acute, (*b*) chronic.

The author explains that he has named his book "Brain Injuries" rather than "Fractures of the Skull", as he is anxious to emphasize the great importance of the brain injury, the question of a fracture or not being only of minor significance. Indeed, as he points out, excluding depressed fractures, the presence of a fracture may be beneficial rather than otherwise, as it opens a way for relief to the all-important increase in intracranial tension. This aspect is insisted on again and again.

After giving the signs and symptoms of acute brain injuries, the author goes on to describe the changes in the fundi of the eyes, and the variations in pressure of cerebrospinal fluid as revealed by the spinal mercurial manometer at lumbar puncture. He lays great stress on these two methods of diagnosing increased intracranial pressure, and on their value as indicating the necessity or otherwise of operative procedure.

In the chapter on treatment he points out that two-thirds of the cases of acute brain injury (excluding depressed fractures) get well on expectant treatment, but the other one-third will require operation to relieve intracranial tension after the initial shock has been recovered from. His contention is that a percentage of this one-third, if not operated on, subsequently develop a chronic 'wet' brain to which he attributes the ill effects—headache, dizziness, etc.—so often seen after head injuries. Certainly his figures show the soundness of the principles underlying this line of treatment. In regard to this aspect of the subject, a very useful part of the work is that dealing with these injuries from the point of view of the Workman's Compensation Act. Emphasis is laid again and again on the necessity of taking the intracranial tension as the guide to treatment, and on diagnosing this early, long before the stage of onset of classical symptoms of bulbar pressure. One cannot but agree with this, and the importance of it renders repetition advisable, but its constant reiteration becomes at times rather irksome. There is nothing in the actual operative technique to notice especially, beyond the author's preference for a vertical incision instead of the usual curvilinear one ; his reasons for using this incision are the greater ease with which hæmorrhage is controlled, the easier access to the base of the skull, and the preservation of the attachments of the temporal muscle.

In Part 3, which deals with brain injuries in the newly-born and children, the necessity of recognizing intracranial tension is again emphasized. Here it is claimed that early operation would prevent many cases of spastic diplegia, and the impaired mentality associated therewith. Sixty per cent of these are due to intracranial hæmorrhage at birth, and would be prevented by an early operation to relieve the accompanying pressure.

Not the least interesting and instructive material in this excellent book is the recital of a large number of cases with full clinical histories, treatment, the subsequent progress of the patients, and the comments on each. Also an attempt is made to recognize the common mistakes in diagnosis by a routine post-mortem examination. The result of such an examination is attached to the history of the fatal cases.

The book is well illustrated, and has a comprehensive index, not only for the subject matter, but also for the illustrative cases.

Diseases of the Nose, Throat, and Ear. By W. S. Syme, M.D., Surgeon to the Ear and Throat Hospital, Glasgow. 8vo. Pp. 329 + viii. Illustrated. 1920. Edinburgh : E. & S. Livingstone. 9s. net.

In this little manual the author has given us his experiences in this branch of medicine, and states that they are the outcome of his "own practice and observations", and he expresses the

hope that "it may stimulate the interest of students in the speciality". We have little doubt that his wish will be fulfilled, because he has succeeded in giving a condensed and practical résumé of the subjects he has dealt with. The book is written in a chatty and easy style, and one can imagine that a stenographer has been present in the clinics and that his transcription is represented by the volume before us. Only on some such assumption can we account for many little errors and omissions which, from a personal knowledge of the author, we feel he would be the first to acknowledge and to correct in a future edition.

We hope the author will give us another edition of this useful little manual, but only on condition that he himself carefully revises it before it is handed over to the publishers.

Industrial Medicine and Surgery. By HARRY E. MOCK, B.S., M.D., F.A.C.S., Assistant Professor of Industrial Medicine and Surgery at Rush Medical College, etc. 8vo. Pp. 846, with 210 illustrations. 1919. Philadelphia and London: W. B. Saunders Co. 42s. net.

THIS work is designed to deal fully with the highly important subject of the preservation, and if necessary the restoration, of the health of employés in the industrial world; and it covers much ground which has hitherto been almost ignored by physicians and surgeons in this country. It is, in fact, the first attempt with which we are familiar, to deal completely with the medical problems upon which industrial efficiency so largely depends. As such its study is almost an essential to those who are engaged in directing the activities of a Ministry of Health, while it is full of valuable information for those engaged in factory inspection and in public health work generally, as well as for employers of labour and the technical advisers of trade unions. With a view to making it thus available for the public as well as the profession, it is written in non-technical language; and it is more bulky, even if more readable, than it need have been if designed for the surgeon only: but it contains much valuable information not readily obtainable elsewhere, and it should at least be open to consultation by all those engaged in industrial practice.

From the point of view of the surgeon, it makes no attempt to deal with the problems of the consulting-room, except perhaps in the chapters upon compensation, insurance, and other 'medico-legal' problems; but even upon the most highly technical questions it occasionally throws light. Thus it is interesting, in connection with a recent discussion by many distinguished surgeons upon the efficacy of iodine for sterilizing the skin, to note the remarkable diminution in septic infection after wounds of the hands, fingers, etc., produced by the systematic and immediate application of iodine to the injured part. "In 1909, when I first used iodine in every department of the industry with which I was connected, there was an immediate reduction of 28 per cent in the number of infections in the first month after this plan was installed." Other sections of the book which may be read with profit are those relating to mechanotherapy, functional re-education and the like, and to such important economic questions as injuries of the hand and the care of the feet.

Venereal Diseases: their Clinical Aspect and Treatment. By J. E. R. MCDONAGH, F.R.C.S., Surgeon to the London Lock Hospital. Pp. 419 + xii, with 106 coloured and 21 other illustrations. 1920. London: Wm. Heinemann Ltd. £3 3s. net.

THE reader who is acquainted with Mr. McDonagh's work during the past decade will expect to find in his latest book, now under review, an exposition of much original thought energetically expressed, and he will not be disappointed. He will be prepared to accord it that measure of respect which is due to the author's brilliant intellect, and the painstaking research with which he supports his theories; and if he does find much in Mr. McDonagh's theories and their practical application to treatment which does not seem entirely to accord with his own experience, he will freely admit that the book has somewhat shifted his view-point and has perhaps stirred him out of that routine line of thought which so sadly interferes with progress. The present book, as its title implies, is mainly concerned with the clinical aspect of venereal lesions and their treatment. The pathological aspect is touched upon only for the purpose of explaining clinical events and treatment; but a work devoted purely to the pathology of venereal disease is promised at an early date. As an exposition of the clinical features of venereal disease we have no hesitation in considering this the best modern work on the subject. The descriptions are excellent, and are illustrated profusely by coloured plates which show that the author was determined to spare no pains to convey his meaning to the mind of the reader. It is true that some of the plates have not entirely escaped that artificial touch which is so common in coloured representations of clinical lesions; but the author does not claim to teach entirely by the book; he very properly insists on the necessity of studying the living specimen. On the question of treatment Mr. McDonagh has pronounced views which appear at first to be widely different from those at present regarded as orthodox, and may not yet receive universal acceptance; but it will be found possible to agree with most of the author's teaching. Frankly, we would hesitate to treat a case of syphilis with

maximal doses of arseno-benzene at short intervals, relying on intramine and colloidal iodine to save the susceptible patient from poisoning by this procedure, because we have somewhat frequently seen these remedies fail to save the situation ; on the other hand, we heartily agree with the advice to commence before the disease has become generalized and to follow up the first course of arseno-benzene and other injections with further antisyphilitic treatment for a period of many months. We would not take the author's view that the urethroscope is practically useless, but we certainly agree that much of the tinkering to which the genital passages are subjected, and much of the caustic with which they are tortured, might well be omitted. This fault is largely due to the lack of clinical as distinct from book experience of many workers at the present day. In this matter Mr. McDonagh is giving the pendulum a strong push in the other direction ; but we feel that the steadying influence of clinical experience will have its usual effect. As is well known, Mr. McDonagh places chief reliance in gonorrhœa on local washing, on his own chemotherapeutic agents, colloidal manganese and palladium with colloidal iodine and intramine, and on the use of detoxicated vaccines. As to the value of the colloidal remedies mentioned, there are differences of opinion, and the reader must decide the question for himself by clinical trial.

It is not unfair to Mr. McDonagh to advise the reader who is unacquainted with the subject of venereal disease not to confine his study to this book, but to read also one in which pathology and treatment proceed on more orthodox lines. His reading of both works will not enable him to form a judgement ; yet, if he will carefully study the living book also, though he may not agree entirely with Mr. McDonagh in the end, he will find that he has profited far more by reading this work than if he had confined himself to an ordinary text-book.

Gonococcal Infection in the Male. By Norman Lumb, O.B.E., M.B., B.S.(Lond.) Large 8vo. Pp. 328, with 165 illustrations (including 35 fully coloured). 1920. London : Bale, Sons & Danielsson Ltd. 25s. net.

This work appears to be largely based on the author's experience as officer-in-charge of a gonorrhœa division of a large military V.D. Hospital, and doubtless on his opportunities of comparing his experience with that of others in the same Hospital, which afforded him access to the records of about 50,000 cases of gonorrhœa. As a result of this and his careful study of modern works, the author presents a digest of the subject which will be found of great practical value by practitioners and students. The outstanding feature of the work is undoubtedly the section on urethroscopy, to which one-sixth of the text and nearly half the illustrations are devoted. The author states his belief in this connection that, without urethroscopy, a high standard of cure cannot be attained. The technique is described very completely, and illustrated by numerous valuable reproductions of photographs of the actual procedure. In addition there are a number of coloured plates showing the appearance of the urethra in health and disease.

Only a few points appear to call for criticism, which is offered in the hope that it may prove useful in the preparation of future editions. On page 28 the two-glass test is described as a useful guide to the condition of the anterior urethra when the acute stage is passing off ; but in the next paragraph the author advises a much more complicated method of examination, apparently for use in the same stage of the disease. If the first-mentioned is a useful and reliable method, which we rather doubt, there would appear to be no necessity for the more troublesome second method. On page 33, in considering examination of the urine in the *acute* stage, it is stated that palpation of the anterior urethra and massage of Littré's glands enables the surgeon to diagnose littritis, apparently because the urine passed after this manœuvre contains many light comma threads. The author omits to mention how he distinguishes these threads in the turbid urine of acute gonorrhœa, or how he detects any but gross infiltrates by palpation of the empty bladder. The method of aborting gonorrhœa in its earlier stages by instituting injection of silver nitrate so strong as 10 gr. to the ounce, which the author favours after irrigating for two days (p. 52), requires very careful selection of cases, since its failure to abort the disease may leave the patient in a bad condition for subsequent treatment. We suggest, therefore, some tightening of the conditions which determine suitability for this form of treatment.

The author has not been so successful in arrangement of his section on complications as in that of other parts of the book. Thus the subjects of arthritis and tenosynovitis are followed by peri-urethral abscess, cowperitis, cystitis, and warts, incidentally all within Chapter X, which is headed 'Arthritis'. These are followed, in the next chapter, by descriptions of keratodermia blenorrhagica, thrombosis of the dorsal vein of the penis, œdema of the prepuce, abscess of Tyson's gland, suppuration of lymph glands, para-urethral tracks, infection of the rectum, endocarditis, and syphilis complicating gonorrhœa, all in the order named, so that it is rather difficult to understand the principle of the arrangement. If we may venture one more criticism, we would suggest that keratodermia blenorrhagica, though a most interesting complication, is too rare to deserve twelve pages of text and eight plates in a work of this size. Our criticisms relate, however, to not important details, and should not detract very greatly from the value of this useful book.

Anæsthetics: Their Uses and Administration. By DUDLEY WILMOT BUXTON, M.D., B.S. Sixth edition. Demy 8vo. Pp. xiv + 548, with 97 illustrations. 1920. London: H. K. Lewis & Co. Ltd. 21s. net.

IN order to bring this work up to date, the author has introduced a good deal of new matter and remodelled some of the old.

The chapter on complications and accidents gives us a fair résumé of what may be regarded as established facts concerning shock, and this chapter now includes a new section dealing with hæmorrhage, and a description of blood transfusion which might with advantage have been written much more fully.

As to new or modified methods, Dr. Buxton gives special consideration to the employment of warmed anæsthetic vapours; anoci-association; intratracheal chloroform; gas and oxygen; and spinal and regional analgesia.

One realizes that the information contained in this book has been well selected, and that the views expressed are reliable and well established.

Manuel d'Uretroscopie. By ROBERT HENRY and ANDRÉ DEMONCHY; with a Preface by Dr. MARION. Pp. 116; 86 figures in the text, 30 in colour. 1920. Paris: Masson et Cie. 25 fr. net.

THIS small volume contains a description of the urethroscope and its use. A number of varieties of the instrument are described in detail; one chapter is devoted to the technique of urethroscopy and another to a discussion of the different forms of urethroscope. The relative values of an external reflected light and an internal light are considered, and the authors decide in favour of the latter. Dr. Demonchy has introduced a modification of the Luys urethroscope, with a small telescope in place of a rotating lens, and this is fully described and illustrated.

Chapter V deals with the normal urethra, and is illustrated by twelve excellent coloured urethroscopic views. In Chapter VI (8½ pages) pathological conditions of the urethra are described. Most of this chapter is occupied by a description of urethritis and stricture. Growths of the urethra are mentioned, but not described. Urethroscopic treatment is discussed, and urethroscopy in the female is the subject of a short note.

The book is written in a simple, easily-read style. It is printed on good paper and the illustrations are numerous and useful. The black-and-white illustrations are well drawn and done in the delicate line typical of French medical illustration. The coloured urethroscopic views are good and are more natural than any we have seen in similar French medical works.

The discussion of pathological conditions of the urethra is meagre, and if extended would add greatly to the practical value of the book. The manual is recommended as a useful introduction to the study of urethroscopy.

SHORT NOTES ON BOOKS.

Massage: its Principles and Practice. By JAMES B. MENNELL. Second edition. With 167 illustrations. 1920. London: J. & A. Churchill. 21s. net.

WE greatly welcome this second edition of Dr. Mennell's important book, not only because of the conviction and the enthusiam which inspire him, but because it represents the actual practice now being so successfully carried out at St. Thomas's Hospital.

The chapters on the re-education of muscle, the combination of massage and splintage in orthopædic surgery, and the re-education of amputation cases represent the new features of the present edition, and the general principle is again and again enforced that massage is merely a small part of the general method of rehabilitation of injured tissues for renewed functional activity.

DaCosta's Modern Surgery. Eighth edition. Pp. 1696, with 1177 figures, some of them in colour. 1919. Philadelphia and London: W. B. Saunders Co. 37s. 6d. net.

THIS is a remarkable testimony to the energy and resource of the author, who produced the last edition in 1914, and now, in spite of the war and the absence of his assistants, has given us this new volume with nearly 200 pages more letterpress and many more illustrations than the last. The work is one of the few survivals of the single-author surgical text-book, though its writer acknowledges the assistance of many colleagues. As in former editions, the illustrations do not conform to a modern standard of excellence. The preface, with its racy quotations, is the most readable part of the whole book, and the volume is closely packed with sound surgical teaching.

SIR CHARLES BELL, K.G.H.

1774–1842.

Sir Charles Bell, physiologist, surgeon, artist, critic, and anatomist, was born in November, 1774, the youngest of the six children of an old Jacobite minister of the Episcopal Church of Scotland who had married a granddaughter of Bishop White, Primus of Scotland. His father's cure at Doun in Menteath was worth twenty-five pounds a year, and the family circumstances were so straitened that the schooling of an elder brother could not be continued after he was eleven years old, although the fees only amounted to five shillings a quarter. Yet, in spite of this, two brothers were educated for the law and two entered the medical profession, and three of the four qualified for admission to the Dictionary of National Biography. The old minister died in 1779, and Charles owed his early education to his mother. From her he inherited the refined taste, the skilful pencil, and the artistic temperament which added so much to his enjoyment of life whilst it militated against his success as an operating surgeon; for he hated to give pain, and there were no anæsthetics.

The family was singularly united and, as one after another rose in the world, each did his best to help the rest. Between Charles Bell and his brother George Joseph, his senior by four years—who afterwards became Professor of Scots Law in the University of Edinburgh—there was a lifelong and almost daily interchange of letters showing the deepest affection on both sides. Charles passed without distinction through the High School at Edinburgh, and was then taken in hand by John Bell, his brother, nine years older than himself. John Bell had already become a surgeon and teacher of surgery of some eminence in Edinburgh, and the two brothers soon published an *Anatomy of the Human Body* in four volumes. It became a standard work, ran through several editions, and was translated into German. Like other works published by the two brothers between 1797 and 1804, it is illustrated with excellent etchings and engravings made from drawings by Charles Bell. About the year 1800 arose the 'Dawplucker' controversy, one of those professional quarrels conducted with bitter personalities which were not unusual in London, Dublin, and Edinburgh at this period. In this particular case it raged between Professor Gregory and John Bell, and resulted in the exclusion of Bell from the Royal Infirmary, the retirement of Charles to London, and the subsequent censure of Gregory by the College of Physicians for his 'perversion of the truth'.

Bell arrived in London in November, 1804, with a slenderly-lined purse and without introductions. He had, however, already made his name as a teacher of surgery; he was acquainted with Longman, who had published his books, and he was known directly or indirectly to men like Brougham, Horner, and Jeffrey, who had all been educated at the High School and were struggling to make their names in London.

Bell took lodgings at 10, Fludyer Street, Westminster, and called upon the leading men of the profession, Sir William Blizard, Abernethy, Lynn, Dr. Maton, Wilson who carried on the Great Windmill Street School of Medicine, and even Sir Joseph Banks. He was always well received, as a young man of talent with pleasant manners and ready to work. For a year he remained in his lodgings, turning his anatomical knowledge to account by teaching artists, drawing from the life at the Royal Academy school, and completing the book on *The Anatomy of Expression* which he had brought with him from Edinburgh. In September, 1805, he rented with much trepidation a dilapidated house in Leicester Street, Leicester Square, which had formerly belonged to Speaker Onslow. Taking a builder with him, his fears were not lessened by the report that the roof alone would want "hundreds spending upon it" and that he had "better have nine bastard children than

this house over your head". The report was evidently exaggerated, for he obtained an estimate and found a man who undertook to put it in complete repair for £20 and keep it so for £3 a year. He borrowed the necessary money of his brother, took possession, and immediately began to lecture in it upon surgery and anatomy. Professor William Gibson, of the University of Philadelphia, who was one of his pupils, tells a good ghost story of the house in his *Rambles in Europe*, published in 1841.

Bell worked diligently, lecturing for an hour and a half, usually twice and sometimes three times a day, but pupils came slowly and patients more slowly still, so that he often got disheartened.

In 1807 he occupied himself with some speculations on a New Anatomy of the Brain, but his ideas received little encouragement, though they contained the germ which afterwards made his name famous as a physiological anatomist. In this year, too, he published a work on the treatment of strictures. In 1809 he made a journey to Portsmouth and visited the wounded who had just arrived at Haslar after the battle of Corunna; by so doing he gained a knowledge of gunshot wounds which proved of the utmost value in 1815, when he went to Brussels immediately after the battle of Waterloo and rendered good service to the wounded French prisoners. In 1811 he put together his speculations on the New Anatomy of the Brain, which had occupied his attention for many years, and published it in the form of a letter which was privately printed. It fell dead, but was afterwards useful in establishing his claim to priority. In this year he married Marion Shaw, a sister of his brother George's wife and of his two favourite pupils, John and Alexander Shaw. The marriage was one of the greatest happiness, although there were no children; his wife, though delicate at first, long outlived him and died at the age of 80. She brought him a small dowry, which was spent in acquiring a share in the Hunterian School of Medicine in Great Windmill Street. In April, 1814, he was elected Surgeon to the Middlesex Hospital by a majority of 265 votes in a poll of 473. Comparing the state of the hospital when he entered with that in which he left it on retiring a quarter of a century later, he says: "At this time a third part of the old hospital was an asylum for poor Frenchmen, and John Shaw was the only dresser; in 1836 the hospital has been enlarged with additional wings, the wards are full, and there is £120,000 standing to its credit in the Funds". Bell soon attracted students to his lectures, and proved himself an excellent operator. His horror of giving pain, however, made the operations nearly as painful to himself as to the patient, and he envied those who, like Astley Cooper, were able to pursue the even tenor of their way, doing their best for the patient and not greatly regarding the issue. Yet, in spite of this infirmity, he remained operating in Brussels after the battle of Waterloo from six in the morning until seven at night on three successive days. In 1821 he communicated his matured discoveries on the nervous system to the Royal Society, and in 1824 he was elected Professor of Anatomy and Surgery at the College of Surgeons. His lectures were well received by a highly critical audience, and the substance of them was afterwards published by the Society for the Diffusion of Useful Knowledge under the title of *Animal Mechanics*. On the accession of William IV he was made a Knight of the Guelphic Order of Hanover, the honour being at the same time conferred upon Herschel, Ivory, Leslie, and David Brewster. On the foundation of the London University, Bell was nominated the first Professor of Physiology, but he was soon dissatisfied with the University management, and resigned. Some premonition of failing health caused him to resign his position in London in 1836. He returned to Edinburgh, and was appointed Professor of Surgery in the University. Here he devoted all his spare time to fly fishing, a recreation which he had acquired in London and carried out at Chenies, Latimers, and Burford Bridge. He suffered from attacks of angina pectoris, and died in one of them on May 27, 1842, whilst on a visit to some friends at Hallow Park, near Worcester.

Bell has many claims to remembrance. 'Bell's Palsy' and the 'External Respiratory Nerve of Bell' recall his researches on the nervous system; *The Anatomy of Expression* and his *Treatise on the Hand* may still be read with profit; the drawings from his own pencil which illustrate his books are often delightful; whilst his letters give pictures of a bygone life in London which are of the utmost interest.

Charles Bell

On the physiological side he taught that the cerebrum and cerebellum are as different in function as in form ; that the nerves are not single nerves possessing various powers, but are bundles of different fibres which are as distinct in their office as they are in their origin from the brain ; that the nerves of sense, the nerves of motion, and the vital nerves are separate throughout their whole course, though they seem sometimes united in one bundle ; and that they depend for their attributes on the organs of the brain to which they are severally attached. In regard to the nerves, too, he demonstrated for the first time that the nerves of motion are distinct from the nerves of sensation. Hitherto the only attempts made to distinguish their uses had been by performing experiments on the trunks of nerves at a distance from their origins. Bell examined the nerves at their roots and, by experiments on the living animal, learnt the functions of the anterior and posterior roots of the spinal nerves. He also had some idea of specialized tracts in the spinal cord. He thus prepared the ground which was successfully cultivated by later physiologists.

Of *The Anatomy of Expression* Charles Darwin, in his book on the *Expression of the Emotions in Man and Animals*, writes that " Sir Charles Bell may with justice be said not only to have laid the foundations of the subject as a branch of science, but to have built up a noble structure. His work is in every way very deeply interesting ; it includes graphic descriptions of the various emotions, and is admirably illustrated. It is generally admitted that his service consists chiefly in having shown the intimate relation which exists between the movements of expression and those of respiration ". Here again, Bell was the pioneer ; but in this work as well as in his Bridgewater treatise on ' The Hand ' he was hampered by teleology, for as yet there was no theory of evolution.

Here is a picture of Abernethy and the outskirts of London as Bell knew it in 1807. Writing to his brother in September, he says : " Yesterday I took my first ride with Abernethy. We went over Highgate Hill and down on the other side towards Finchley, came round through the most enchanting bye-roads to Enfield, dined at Southgate, and rode home in the afternoon. My companion is quite a peculiar creature, but I believe the infection of my delight made him unusually free and frisky ; and strange to say, in all our ride we met nobody. I gave my companion much credit for the choice of roads, and was not a little astonished to find the principle which guided him thus announced on coming into town thro' the last (turnpike) gate. ' There,' says he, ' I'll venture to say there is not another man who will take you a ride of twenty miles round London for three halfpence.' His avoiding tolls took me through these very roads I delight in ". Now, alas, a weary waste of suburban houses and tramlines !

Dr. Eugene R. Corson drew renewed attention a few years ago to the artistic qualities shown by Sir Charles Bell in he water-colour sketches which he made for the use of the engravers and etchers employed to illustrate his various works. Many of these sketches are preserved—some at the Middlesex Hospital, some at the Royal Army Medical College, Millbank, some in the Surgeon-General's Library at Washington, and a few at the Royal College of Surgeons of England.

The portrait is reproduced from a steel engraving published in Pettigrew's Medical Portrait Gallery.

CARCINOMA OF THE APPENDIX CAUSING DIVERTICULA OF THE APPENDIX AND ACUTE APPENDICULAR OBSTRUCTION.

By D. P. D. WILKIE, Edinburgh.

Primary carcinoma of the appendix is now a well-recognized pathological entity, and the literature contains records of between two and three hundred cases. In the majority, the discovery of the growth has been more or less accidental in the routine examination of appendices removed at operation or post mortem, and for the most part the presence

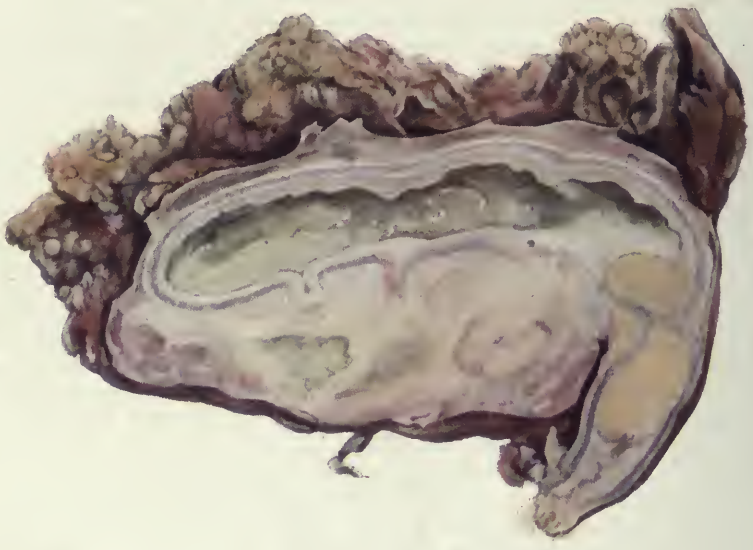

Fig. 242.—Note yellow growth occluding lumen near proximal end, empyema beyond, and diverticulum on mesenteric border near tip.

of the tumour has appeared to be more of the nature of a secondary degeneration than the primary cause of the symptoms of which the patient may have complained.

The following three cases which I have met with in the course of eighteen months are of interest chiefly because in each the presence of the growth in the appendix obstructing its lumen led to very definite acute symptoms which called for operation. Before taking up the special points in pathology which were shown by these cases, the following short clinical notes are given :—

Case 1.—S. W., female, age 15, admitted to hospital June 19, 1918.

Diagnosis.—Acute appendicitis.

History.—Five days before admission, patient was suddenly seized with acute abdominal pain while at her work. She had to stop work and go home to bed. The pain continued intermittently for twenty-four hours and then subsided ; but commenced again on the following day, and for the three days before admission she was never free from pain. Vomiting started two days before admission, and continued at intervals up till the time of operation. The bowels had been very constipated for some weeks.

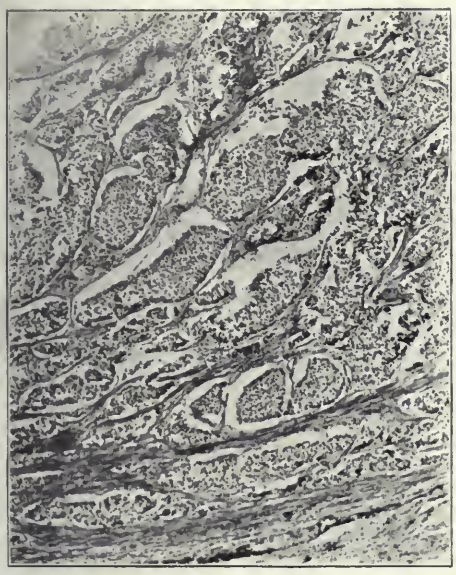

FIG 243.—Low-power view of growth in *Case* 1; spheroidal-celled type of tumour. ×48.

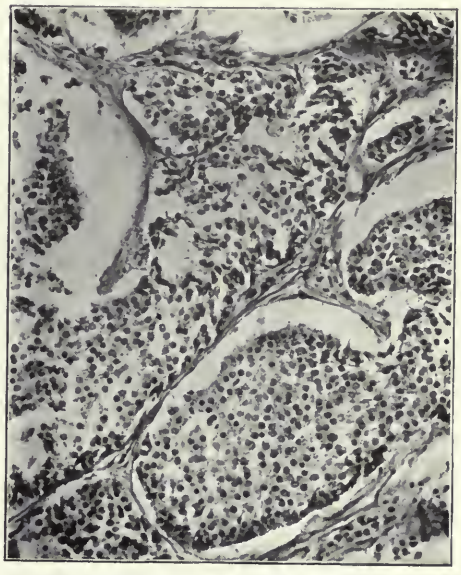

FIG. 244.—High-power view of growth in *Case* 1. ×160.

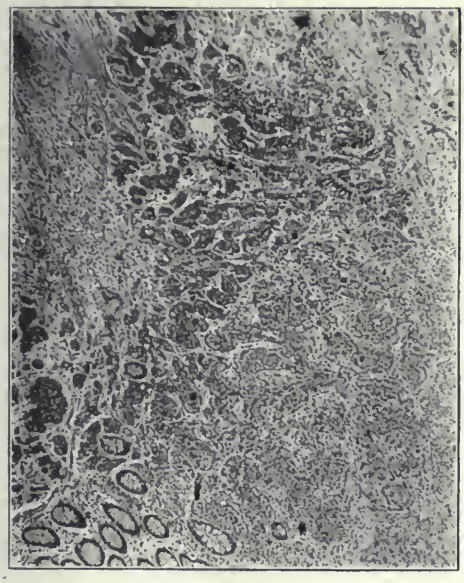

FIG. 245.—Low-power view showing portion of growth with normal mucosa at one corner from *Case* 2. ×48.

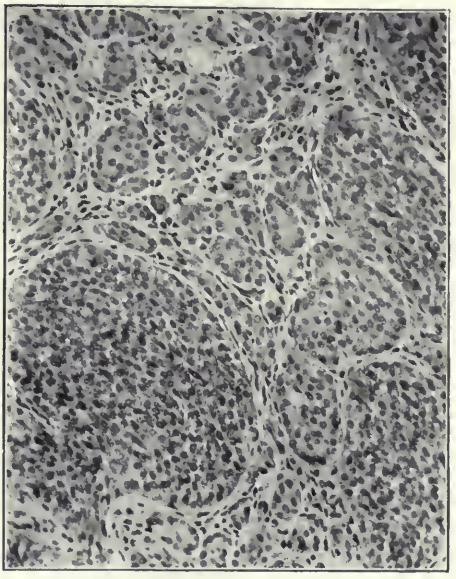

FIG. 246.—High-power view of tumour in *Case* 2. ×160.

On Examination.—The child looked ill. Temperature 100°, pulse 104. There was marked rigidity of the whole of the right side of the abdomen, cutaneous hyperæsthesia over the right rectus muscle both above and below the umbilicus, and definite palpable resistance in the right lumbar and iliac regions.

Operation.—Gridiron incision in right iliac region. Extraperitoneal tissues very œdematous. On opening the peritoneum a firm mass was exposed, covered with omentum and lying external to the cæcum and ascending colon. The omental adhesions were clamped and cut, the base of the appendix exposed and divided, and the large mass peeled off the outer side of the cæcum and ascending colon. A small abscess between the appendix and ascending colon had made its way partially through the wall of the latter. After swabbing away the pus the wall of the colon was repaired with Lembert sutures. A rubber-dam drain was left in along the outer wall of the ascending colon. The patient made a prompt recovery.

The appendix was of unusual size and, on dividing the mass longitudinally, it was seen to be made up of an empyema of the appendix distal to a typical yellow-coloured growth in the proximal half of the organ (*see Fig.* 242). A large part of the mass was made up of greatly thickened and indurated meso-appendix. Sections of the growth proved it to be a spheroidal-celled carcinoma. Sections of the meso-appendix showed no involvement by tumour growth. Several diverticula projecting from the mesenteric border of the appendix indicated that the obstruction of the appendix had been a gradually increasing factor before the final and complete obstruction led to the acute symptoms.

Case 2.—A. J. G., male, age 22, admitted Feb. 9, 1920. Two days before admission the patient was seized with pain across the lower part of the abdomen. The pain was spasmodic in character and continued off and on throughout the night; the following day it was more severe, and was not relieved by hot fomentations. At 4 a.m. on the next day he had very severe spasms of pain. When seen in consultation with his doctor at 10 a.m., he looked ill; his temperature was 101°, pulse 104. There was definite hyperæsthesia and tenderness in the right iliac region, and marked boarding of the muscles on the right side of the abdomen. He was removed to hospital and operated on at once. He gave no history of any previous attacks, and had been in good health before this attack began.

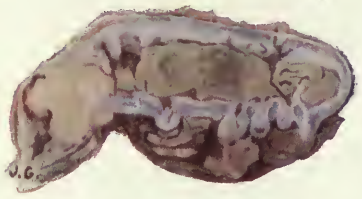

Fig. 247.—Yellow growth obstructing lumen near proximal end of appendix. Concretions beyond. Note numerous diverticula at mesenteric border.

Operation.—Gridiron incision. The extraperitoneal tissues were œdematous. A greatly engorged and distended appendix covered with lymph was found lying under the last coil of the ileum; near its base it was somewhat constricted, and at this point was extremely hard and firm to the touch. As the appendix was delivered through the abdominal wound some fæculent pus escaped through a small perforation. The appendix was removed and the abdomen closed. The patient made an uneventful recovery.

Pathological Report.—The appendix is split longitudinally near its proximal end; the lumen is occupied by a typical yellow carcinomatous growth; distal to this is a concretion surrounded by fluid fæculent material. Along its mesenteric border there are several well-marked diverticula which include all the coats of the appendix (*see Fig.* 247). The perforation seen at operation was through the apex of one of these diverticula. Sections of the growth show the structure of a spheroidal-celled carcinoma.

Case 3.—C. M., female, age 17, admitted Aug. 8, 1919.

History.—For the past year patient has complained almost constantly of her stomach being out of order. Frequently, after meals, she would have epigastric pain coming on at irregular intervals and usually followed by a colicky pain in the right iliac region, and vomiting. After vomiting, both the epigastric and right iliac pains were relieved. She has had several very severe attacks of pain in the right lower abdomen which have doubled her up; she has on three occasions been confined to bed, and was told by her doctor that she had appendicitis. The last severe attack was two weeks ago, but during the long journey to hospital (Shetland to Edinburgh) patient has again had some pain and sickness.

On Examination.—There were found some restriction of abdominal movement—especially on the right side; definite hyperalgesia and tenderness in the right iliac region; no rigidity.

Operation.—A gridiron incision was made. There was no peritonitis; a long engorged appendix, swollen at the tip and with a definite yellowish swelling half an inch from its cæcal end (*Fig.* 248), was removed and the abdomen closed. Uneventful recovery.

Even before the appendix was removed in this case one was able to recognize the carcinoma at the base of the organ and to correlate its presence with the symptoms of appendicular obstruction of which the patient had complained.

Pathological Report.—The appendix, split longitudinally, shows two separate yellow growths, one close to the cæcal end apparently blocking the lumen almost completely, the other at the tip (*Fig.* 249). There appears to be no connection between the two growths, which, on section, show the typical spheroidal-celled carcinoma structure. There is no evidence of any spread of the growths beyond the confines of the wall of the appendix.

These three cases are of interest because, in all, the carcinoma situated near the proximal end of the appendix gave rise to symptoms of acute appendicular obstruction which in two of the cases called for immediate surgical intervention, and in the third case led to repeated attacks until the appendix was removed.

In two of the cases the obstruction, before finally occluding the lumen completely, had caused a chronic increase in tension in the appendix leading to the formation of diverticula, through one of which perforation eventually occurred. In one case (*Case* 3) there were two separate and apparently entirely independent though similar growths in the appendix, the one at the tip, the other at the base.

These three cases were typical of appendix carcinoma in : (1) The early age incidence (15, 22, and 17 years respectively) ; (2) The spheroidal-cell type of growth ; (3) The absence of metastatic glandular involvement.

Fig. 248.—Appendix in *Case* 3. Note yellow growth shining through peritoneal coat near proximal end, and faint yellow nodule at tip.

Fig. 249.—Appendix in *Case* 3 slit open. Round yellow nodule plugging lumen near base, and small yellow growth at tip.

Graham[1] found that, in 172 cases of primary appendix carcinoma, the growth was of the spheroidal-celled type in 127 (73·8 per cent).

Reiman[2] reported 17 cases of carcinoma in 13,157 appendices examined from the clinics of Kelly and Deaver in Philadelphia, i.e., 0·13 per cent. In 75 per cent of the cases the patients were females, and in practically all the cases the tumour was situated at the tip or the distal third of the appendix.

MacCarty and McGrath,[3] in their extensive observations from the Mayo clinic, found that the average age of cases of appendix carcinoma was thirty years, that 73 per cent of the cases were females, and that in 90 per cent the disease was situated near the tip of the appendix. They found carcinoma in one out of every 225 appendices examined, and in one out of every 53 partially or completely obliterated appendices.

The disease is thus shown to be not infrequent and must be often overlooked ; moreover, it is evidently predisposed to by the chronic inflammatory changes which tend to

obliteration of the lumen of the appendix. The disease would appear to be of a peculiarly benign or carcinoid type, and to differ from all other intestinal growths with the possible exception of the carcinoma sometimes met with in the lower ileum.

Aschoff[4] doubts whether one has the right to call the tumour a carcinoma. He points out that it is made up of small solid nests of cells, the mucous membrane over which is usually intact. The microscopic appearance very closely resembles that of the epithelial formations seen in cutaneous nævi, and Aschoff suggests the name 'mucous-membrane nævi' for such growths. Luce[5] supports Aschoff's view, and suggests that these nævi may predispose to inflammatory changes in the appendix, and not be secondary to such changes as has usually been supposed. The descriptive name of 'carcinoma alveolare solidum simplex' employed by some German writers, although somewhat cumbrous, would appear to express as accurately as possible our present knowledge of this interesting growth. The question as to whether a really malignant type of carcinoma occurs in the appendix is still a matter of some doubt. Luce reports two cases of primary malignant carcinoma of the appendix, and from a study of the literature considers that 12 cases of genuine malignant disease have been recorded. In one of his own cases it is very doubtful if the disease was not primary in the cæcum. Reiman found three examples of columnar-celled carcinoma in his 17 cases, but in none was there any evidence of real malignancy.

As McKenty[6] points out, there is so far no authentic case of metastatic growth following a carcinoma of the appendix in which the spread of the disease from the cæcum to the appendix could be definitely excluded.

At present, therefore, we must regard primary growths of the appendix as being of a relatively benign character, and liable to threaten life more from the acute obstructive and inflammatory complications to which they may lead than from any intrinsically malignant properties.

The presence of two independent growths in the same appendix, as occurred in *Case* 3 of my series, is apparently unique; at least I have failed to discover any previously recorded case. If Aschoff's view that the tumour is really a nævus is the correct one, multiplicity is not unnatural. On the other hand, if the growth has locally malignant characters it is possible that the small growth found at the tip of the appendix in this case was the primary one, and that the larger tumour at the base of the appendix was a secondary graft from the lumen of the organ.

The association of diverticula in the distal portion of the appendix with an obstructing tumour in its proximal part is self-evident in explanation. I have found no special reference to it in recorded cases; but in one of the appendices figured in Graham's paper several diverticula are seen distal to the tumour. The practical importance of the presence of diverticula consists in the fact that when complete obstruction of the lumen eventually supervenes, perforation is liable to occur through one of the relatively thin-walled diverticula. To begin with, these diverticula have distinct and well developed muscular coats; but as the diverticula enlarge, these coats become thinned and eventually deficient over their apices, and at such points rupture may occur as in *Case* 2 of my series.

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[1] Graham, *Edin. Med. Jour.*, 1913, x, 30.
[2] Reiman, *Amer. Jour. Med. Sci.*, 1918, clvi, 190.
[3] MacCarty and McGrath, *Mayo Clinic Reports*, 1915, 450.
[4] Aschoff, *Pathologie*, ii, 798.
[5] Luce, *Beitr. z. klin. Chir.*, 1912, lvi, 419.
[6] McKenty, *Ann. of Surg.*, 1912, lvi, 419.

THE TREATMENT OF CONGENITAL HYPERTROPHIC STENOSIS OF THE PYLORUS BY RAMMSTEDT'S OPERATION.

By ROBERT A. RAMSAY, London.

Among the recent advances in knowledge of the subject of congenital hypertrophic stenosis of the pylorus the operation of Rammstedt holds an important place, representing the latest contribution of surgery to the treatment of the condition. It is proposed in this paper to consider the operation from all aspects, giving first a short account of the pathology and general principles of treatment of the condition; and, after discussing briefly other means of dealing with the obstruction, and the indications for surgical interference, to describe Rammstedt's operation in detail, giving an account of the operative technique and of the possible causes, prevention, and treatment of post-operative complications.

PATHOLOGY.

The treatment of the obstruction may be regarded as empirical, for the conflicting theories of its causation indicate that the pathogenesis has not yet been definitely explained.

It has been held that the hypertrophy is the result of spasm occurring after birth, since symptoms do not usually appear before the age of two or three weeks. It has been stated in support of this view that the degree of hypertrophy is in proportion to the age of the patient; but this statement has not been confirmed by all observers. It is hardly credible that the enormous increase in the pyloric muscle can occur in so short a time, while it is certain that pyloric spasm without hypertrophy can produce very similar symptoms.[1] Clinton Dent found an hypertrophied pylorus in a seven-months fœtus, and in the museum of the Royal College of Surgeons of England there is a typical specimen (Teratological Series No. 545.05) from a child who suffered from persistent vomiting from birth and died at the age of one week. It would seem, therefore, that hypertrophy can be, and probably is, present at birth, although obstruction sufficient to produce symptoms may only occur at a later date.

The question as to whether this congenital hypertrophy is a simple error of development or the result of intra-uterine spasm is more difficult to answer. In support of the latter explanation, Tyrrell Gray and Pirie[2] suggest a suprarenal hypertrophy or hypersecretion and consequent abnormal sympathetic action in early fœtal life, as the primary cause; John Thomson[3] argues in favour of intra-uterine derangement of the local nervous mechanism of the pylorus, and points out that the fœtus swallows liquor amnii, thus accounting for intra-uterine action of the sphincter; while Haas[4] describes the condition as a manifestation of vagotonia. The theory of intra-uterine spasm is supported by the limitation of the hypertrophy to the circular muscle of the sphincter. On the other hand, however, there are those who maintain that a simple aberration of development is the true explanation, and are not satisfied by any theory of spasm. Whatever the cause of the initial hypertrophy, it is clear that the lumen of the pyloric canal is not completely closed at birth in the majority of cases, and the reason of its ultimate partial or complete obstruction and of the consequent characteristic symptoms is the subject of further discussion.

Thomson[3] suggests that the continued growth of the muscle, limited on the outside by the peritoneal coat, takes place at the inside and encroaches on the lumen. Tyrrell Gray and Pirie[2] do not apply their theory of adrenal stimulation of the sympathetic to this stage of the condition, since the suprarenals are not found enlarged after birth; they

suggest some other source of irritation of the sympathetic, especially a tight or adherent prepuce, and also a derangement of the chemical control of the pyloric mechanism due to pancreatic insufficiency. In this connection I may state that while I have confirmed from post-mortem examination that the suprarenals are apparently normal in these infants, both to the naked eye and under the microscope, I have found the pancreas also to be normal in size, appearance, and histology; and in the male patients that I have seen, the prepuce has either been loose and not adherent or already removed by circumcision. Haas[4] carries his theory of vagotonia a step further, and considers that continued overaction of the vagus explains the obstruction.

A possible explanation which may be put forward is that the narrowing of the pyloric canal by congenital hypertrophy of the muscle produces slow emptying of the stomach, and stagnation of the contents; this might easily be the stimulus required to set up gradually increasing contraction of the already abnormal sphincter, especially since such spasm can occur in a pylorus with normal muscle; further, œdema could spread from the mucous membrane of the stomach to that of the pylorus, which is already thrown into folds, compressed by the muscle, and irritated by the forcing of food through the narrowed canal. In cases operated upon or seen post mortem the pyloric mucous membrane is seen to be thick and œdematous, while the fluid returned on washing out the stomach shows the presence of stale food and often excessive secretion of mucus.

GENERAL PRINCIPLES OF TREATMENT.

It should be remembered that the main condition to be dealt with is starvation, and the problem to be solved is how to give the infant sufficient nourishment; the methods which may be employed are either operative or non-operative. It is obvious that the ideal treatment is non-operative when this is possible, since, on account of their frequently wasted condition, the patients are not good subjects for operation; there are also several possible post-operative complications which are responsible for a considerable number of failures. But unfortunately non-operative treatment is by no means always successful, and in these cases surgery must be invoked to hasten the starting of such feeding as is necessary for life and growth.

Medical Treatment.—Since it is nearly impossible to tell in any given case whether operation will be necessary or not, medical treatment should be tried in the first instance; for this reason a brief review of the various non-operative measures will be given. The object of medical treatment is so to diminish the contraction and œdema of the pylorus as to allow the canal to revert to the partially patent state present at birth; in this way food, in a reduced quantity at least, can pass, and may be sufficient to maintain life and permit growth in a varying degree. If this ideal is attained and maintained, it is thought that absolute growth of the pylorus will cause the lumen, after prolonged and careful treatment, to become large enough for stagnation and spasm to cease and a cure to result.

Until recent years medical treatment consisted only in feeding in small amounts at short intervals, combined with regular and frequent washing out of the stomach. By these means it is hoped to prevent over-filling of the stomach and consequent stagnation, and to reduce, when present, the inflamed and swollen condition of the mucous membrane. Many drugs have been tried, such as belladonna, opium, and cocaine, but with very unsatisfactory results. Recently two new medical methods have been described in the United States. One consists in giving thick foods, and successful cases have been described.[5] I have not seen this treatment applied. The second method is that of Haas,[4] who gives large doses of atropine in the food with a view to inhibiting the action of the vagus; he increases the dose to as much as $\frac{1}{10}$ gr. in a day when necessary, and describes successful cases. I have seen a case in which this line of treatment was followed by cure, but in a case upon which I afterwards operated the patient showed signs of poisoning before a dose sufficient to affect the symptoms was reached (*Case* 9).

These medical methods of treatment are mentioned here since, in the present state

of knowledge of the subject, it is advisable in most cases that an attempt be made to avoid operation. It is not always easy to be sure that the case is not one of simple pyloric spasm, nor, in a case of true hypertrophy in which the pyloric tumour is distinctly felt, to determine the relative importance of the structural and functional factors producing the obstruction as mentioned above. In cases of pure spasm, or in those in which the actual hypertrophy is slight but associated with much gastritis, medical means will produce improvement which in favourable circumstances may progress steadily and result in cure. It is as well to point out the fact, noted by many, that a change in the method of feeding will often produce an improvement; but in severe cases this is only temporary and is soon followed by a recurrence of symptoms. The important point is that medical treatment as at present known should not be prolonged in the absence of continued, even though slow, improvement, as shown by control of vomiting and especially by gain in weight. The loss of weight occurring when unsuccessful measures are persisted in, is a serious factor in determining a fatal result after an operation that may finally be found unavoidable. The time to be spent in medical treatment must be decided for every individual case, since it depends on the age and weight of the child, its appearance, and general condition and progress; a young child that has not lost much weight when first seen, although not necessarily curable without operation, is obviously less in need of rapid relief of the obstruction than an older child severely wasted and exhausted by vomiting, to whom satisfactory feeding is an urgent necessity. Attempts have been made to fix an arbitrary time to be spent in treatment on medical lines, but no such period can be given. I consider indications for surgical treatment to be present in the case of a child so wasted and exhausted that any more loss of weight is likely to cause a fatal result should an operation have to be done later; and also in the case of a child in whom non-operative methods do not at once relieve the vomiting and produce a continued gain in weight compatible with life and growth.

Surgical Treatment.—In discussing the surgical treatment, it must be remembered that, except in the rare cases operated upon in a very early stage, the object in view is to feed the wasted infant so that it may recover from its marasmus. The object of an operation is merely to provide an outlet from the stomach so that this feeding can be carried out. The difficulties facing the surgeon lie in the extreme youth and unsatisfactory state of the patient, and the consequent susceptibility to shock. In the choice of operation, therefore, two factors must be borne in mind: in the first place, an efficient communication must be established between the stomach and the intestine; and secondly, in order to avoid severe and even fatal shock, the operation should be one that can be done quickly and should entail the least possible exposure and handling of the abdominal contents.

A brief review of the operations which have been adopted shows the superiority of Rammstedt's method. Resection of the pylorus with either gastro-enterostomy or direct union of the divided stomach and duodenum is much too formidable. Pyloroplasty, which consists in dividing all the coats of the pylorus in the direction of the axis of the canal and suturing them at right angles to this, is, as I have found in two cases, very difficult on account of the rigidity of the hypertrophied muscle, and takes a relatively long time to perform; while, because of the distortion of parts, the canal is not immediately patent. Other plastic operations present the same difficulties. Gastro-enterostomy requires exposure and handling of more than one part of the alimentary canal, and the suturing takes an appreciable time.

The modification of Loreta's operation—in which metal dilators, introduced through an incision in the stomach wall, are passed through the pylorus in increasing sizes until the circular muscle is ruptured—is not a short operation, allowing the time needed for the incision and suture of the stomach and for the necessarily slow and gentle passage of the dilators. While it is undoubtedly true that the band of muscle actually causing the constriction is ruptured, the situation and extent of this rupture is uncertain.

Weber's[6] extramucous pyloroplasty, as its name implies, is a plastic operation leaving the mucous membrane untouched and involving the muscle only; this procedure

would appear to suffer from the same disadvantages as are mentioned in the case of the older form of pyloroplasty.

Russell Coombe[7] described an extramucous division of the muscle in the axis of the canal, the peritoneum being freed from the muscle and sutured over the gap, a detail of technique prolonging the operation and shown to be unnecessary by the results of Rammstedt's method.

RAMMSTEDT'S OPERATION.

History.—The operation of dividing the hypertrophied muscular coat in the axis of the pyloric canal, leaving the mucous membrane intact and using no sutures to close the gap, was first described by Rammstedt[8] in 1912. While attempting to perform the extramucous pyloroplasty of Weber, it was found that the sutures would not hold, and the patient's condition preventing prolonged attempts to complete the operation, the incision in the muscle was left open. Recovery followed, and the possibility of leaving the muscular incision unsutured being thus proved, this was done deliberately in other cases. The operation was taken up extensively, with favourable results, in the United States, and more recently in this country. It has the advantage of simple technique, rapidity, and exposure of the least possible amount of abdominal contents, since the pylorus itself and the adjacent part of the stomach are all that need be brought out of the wound.

In a paper read before the Medical Society of London in February, 1919,[9] I discussed and compared the various operations, and attempted to show the superiority of Rammstedt's operation; I have had other cases since that time, and describe here in detail the operative technique used and the observations made.

Preparation for Operation.—Before the operation the limbs are bandaged and a subcutaneous infusion of saline is given. The theatre and table are warmed, and all the usual measures are taken for the prevention of shock. Before starting the administration of the anæsthetic, the stomach is washed out with a solution of bicarbonate of soda until the fluid is returned quite clear. This is done for several reasons: first, an empty stomach, or one containing only gas, is easier to handle than one distended with food; secondly, should an opening be made accidentally in the mucous membrane the risk of infection is lessened; thirdly, on the re-establishment of the pyloric canal, stagnant food and mucus do not pass into the easily irritated intestine; and finally, should regurgitation through the œsophagus occur during the operation, the danger of respiratory obstruction is diminished. In one of my cases (*Case* 6) breathing was stopped by a plug of mucus, and, although this was satisfactorily dealt with, the delay and necessary moving of the patient might have had serious results. Since this case a large tube (No. 14 English) has been used, so as to assure the removal of all food and mucus.

Anæsthesia.—The anæsthetic is a matter of great importance. Although in the case of such weak and wasted patients the temptation to maintain a light degree of anæsthesia is certainly present, it must be resisted, since deep anæsthesia is necessary to prevent shock and also to avoid straining and protrusion of omentum or viscera, which, should it occur, will increase the shock and delay the operation, the replacement of such a protrusion being often difficult, especially in the case of thin and wasted omentum. In my cases open ether has been used; its stimulant effect is of value, while, if induction is very gradual, the respiratory complications are avoided. I have not done the operation under local anæsthesia, and should hesitate to do so, since straining and its important results, as mentioned above, could not be prevented with certainty. I have not used spinal anæsthesia, which would have to be at a very high level in view of the part of the abdomen dealt with.

I am indebted to Mr. F. D. Bennett and Dr. Howard Jones for their help and advice on the subject of the anæsthesia.

Operative Technique.—The incision of the abdominal wall is that employed by Mr. Burghard in his modification of Loreta's operation. It is from $1\frac{1}{4}$ inches to $1\frac{1}{2}$ inches in length, in the middle line, extending downwards from the tip of the ensiform cartilage.

It is small and therefore quickly closed, since only the pylorus need be brought out of the wound ; it is in the middle line so as to avoid hæmorrhage, and to reduce the layers of suturing in the process of closure ; and it is placed as high as possible so that the large liver of the infant, which is rotated upwards to expose the stomach, can, at the end of the operation, fall back into its natural position, fill the wound, and so help to prevent protrusion of abdominal contents. As soon as the abdominal cavity is opened it is as well to secure the cut edges of peritoneum before they retract, and thus avoid delay when the time for closure comes (*Fig.* 250). When the lower edge of the liver has been hooked upwards, the stomach appears in the wound ; the diagnosis having been confirmed by feeling the pyloric tumour with a finger introduced into the abdomen, this tumour is brought out of the wound ; in some cases it can be hooked up by the examining finger ; in others, pushing the stomach backwards and to the left may cause it to present ; or, in the case of a greatly dilated stomach, it may be necessary to exert gentle traction upon

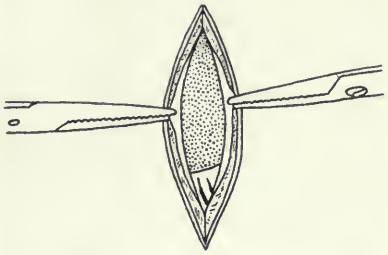

FIG. 250.—Shows abdomen opened. Liver fills greater part of wound. Stomach seen below. Forceps on peritoneal edges.

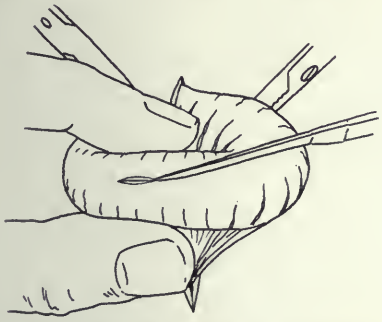

FIG. 251.—Shows pylorus held by left hand and incision begun.

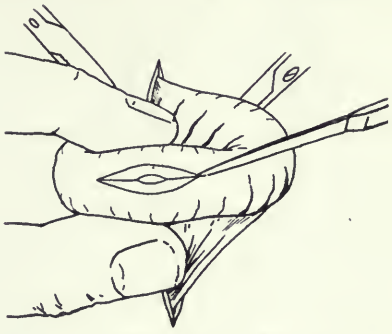

FIG. 252.—Incision deepened. Mucous membrane exposed in middle.

the exposed part of this organ and so bring the tumour within reach. The pylorus being delivered, the extent of the hypertrophy is carefully defined by palpation, and, with the tumour held firmly in the left hand, a longitudinal incision is made upon its anterior surface in the relatively bloodless area lying between the terminal branches of the vessels running along its upper and lower borders (*Fig.* 251). The incision should divide the whole of the hypertrophied muscle ; it should be deepened carefully at first in the middle or thickest part, the left hand drawing apart the edges of the incision until the deepest part of the muscle is divided and retracts, exposing the thick white mucous membrane, which at once protrudes (*Fig.* 252). The incision is then prolonged towards the stomach and duodenum until all the thickened muscle is divided. Great care must be taken not to wound the mucous membrane, especially at the duodenal end of the incision, since here the hypertrophy ends abruptly and protrudes into the lumen of the intestine, producing a cul-de-sac of duodenal mucous membrane which may easily be

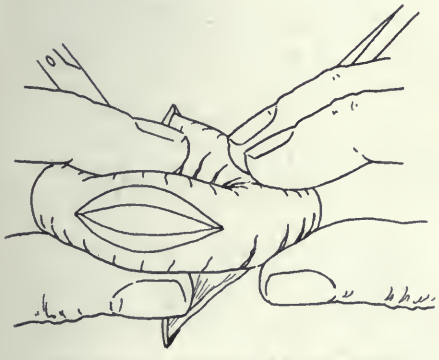

FIG. 253.—Incision completed. Margins separated by left hand. Stomach compressed by right hand.

injured. When the muscle has been completely divided, the edges of the incision retract and the redundant mucous membrane bulges freely into the gap. Hæmorrhage in the form of oozing may occur, especially at the end of the incision which encroaches on the stomach; this can usually be controlled by hot sponging, but if, as sometimes occurs, a definite bleeding point is responsible, it should be under-run and ligatured with fine catgut. The patency of the canal may be tested by gently squeezing the stomach, and this precaution also serves to demonstrate the absence of macroscopic perforation of the mucous membrane (*Fig.* 253). The pylorus is now returned to the abdomen, and the liver allowed to fall into place. The closure of the abdominal wound is begun at the lower end, since it is here that protrusion of abdominal contents is most likely to occur; a continuous suture of fine silk closes the peritoneum and aponeurosis in one layer, and a continuous blanket suture of silk or fishing-gut is used for the skin. Dressings having been applied, the patient is returned to a warm bed, saline with brandy is given per rectum, and feeding is begun as soon as possible.

Anatomical Results.—The immediate anatomical result of this operation consists in division of the constricting band of hypertrophied muscle, which at once retracts and frees the redundant and compressed tube of mucous membrane, the lumen of the latter being ample for the passage of food. As regards more remote changes, I have examined four stomachs at varying intervals after Rammstedt's operation, and the facts noted help to demonstrate the process of repair and the ultimate local result.

FIG. 254.—Stomach 17 days after Rammstedt's operation. (*Natural size.*)

In the case of a patient (*Case* 6) who died of hyperpyrexia twenty-six hours after operation, the pyloric canal was patent and the stomach not distended, although food had been given at regular and frequent intervals, and vomiting had been insignificant. The edges of the incision in the muscle were widely separated, and the mucous membrane was not compressed; the exposed area of mucous membrane filling the wound was intact and covered by a layer of firm blood-clot $\frac{1}{8}$ inch in thickness; there was no hæmorrhage into the abdominal cavity, and no sign of adhesions or of peritonitis.

In the case of a patient dead on the seventh day from no apparent cause except failure to assimilate, the stomach was not dilated and the pylorus was patent. The margins of the wound in the muscle were widely retracted, the mucous membrane uncompressed and covered, in the gap, by a layer of organizing lymph; there was no sign of adhesion, peritonitis, or hæmorrhage.

In the case of a patient dead of diarrhœa on the seventeenth day, the pylorus was patent and the stomach not distended. The layer of lymph covering the exposed mucous membrane was now organized, blended with the cut edges of the muscle, and partly covered by peritoneum. There were no adhesions. This specimen (*Fig.* 254) is now in the museum of St. Bartholomew's Hospital (No. 1907.A.5.).

In the case of a patient dead of diarrhœa and vomiting after four and a half weeks, the changes were similar to those found in the last specimen, but the edges of the cut muscle were less distinct and more completely blended with the surface of the gap. The lumen of the pylorus was patent. A microscopical section of this specimen cut at

right angles to the axis of the canal shows the thickened muscle ending in a rounded edge on each side of the gap ; these muscular edges are united across the gap by a thin and loose layer of fibrous tissue. The mucous membrane shows longitudinal folds, but is unconstricted, and the lumen of the canal is patent (*Fig.* 255).

I have not seen any specimen of a stomach after a longer interval than in the last case, but Ransohoff and Woolley[10] describe a case dead from other causes five and a half months after Rammstedt's operation, and state that the muscle was of normal thickness, while in the site of the incision was a shallow linear depression. The bottom of this groove was shown on a microscopical section to be connected to the submucous coat by a band of fibrous tissue ; the pyloric canal was patent and the stomach not dilated.

After-treatment.—The immediate results of the operation having been overcome, the subsequent after-treatment has for its object the feeding of the patient and recovery from marasmus. In most of my cases this has been carried on under the supervision of Dr. Cautley. As soon as the effect of the anæsthetic has passed off, a weak preparation of Horlick's malted milk is given in feeds of 1 drachm every quarter of an hour, brandy being added until the colour and pulse are satisfactory. After twelve hours the quantity and interval are doubled, and so on until after thirty-six hours the patient is taking an ounce hourly. The food is gradually increased in strength and quantity according to the needs and progress of the patient, great care being taken to avoid sudden increase or over-feeding in view of the ease with which the intestines are deranged and diarrhœa produced. During the first week the patient may gain in weight or remain stationary, but after this interval a steady and continuous gain should occur, and the appearance of the child should alter from that of severe marasmus until it becomes a healthy though, at first, small infant, the drawn and sunken features being the first sign to disappear.

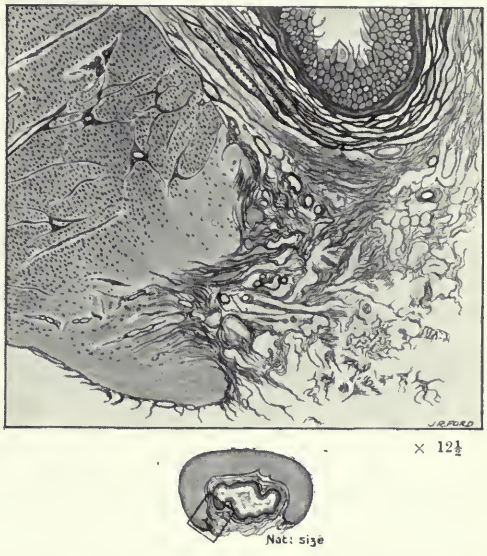

FIG. 255.—Transverse section through pylorus 4½ weeks after operation. The divided muscle is widely separated, the lumen large, and the gap in muscle becoming replaced by fibrous tissue.

Complications.—What has just been described is the progress and cure of a successful case ; unfortunately there are certain important complications which may occur in the post-operative period, and any of these may bring about a fatal result, even though the primary object of providing an outlet from the stomach has been achieved.

Shock.—As has already been pointed out, the operation under discussion is especially valuable in avoiding shock, on account of its short duration and of the small amount of manipulation required ; I have not had a case in which shock was severe or in which such shock as was present was not readily overcome by the usual simple methods.

Hæmorrhage.—Although in none of my cases has there been hæmorrhage sufficient to cause symptoms, this complication is sometimes a cause of death, blood being found post mortem in the peritoneal cavity in considerable quantity. The main arteries involved are the pyloric and right gastro-epiploic vessels which run along the upper and lower borders respectively of the pylorus ; these vessels send branches to the pylorus, some to the anterior and some to the posterior surface ; and in front where the incision is made there is an intermediate space between the terminations of the upper and lower groups of branches where the muscle contains no important vessel and is relatively

bloodless ; as the pylorus merges into the stomach the vessels become larger and more numerous. Wishing to demonstrate this bloodless area, I injected the abdominal arteries of a fœtus through the aorta with a suspension of red lead and removed the stomach, of which skiagrams were taken for me by Mr. H. T. George (*Fig.* 256) ; these plates show clearly the distribution of the vessels and the bloodless area to which I have referred, and I consider it important to divide the pyloric muscle in this situation.

Peritonitis.—Peritonitis is a complication which I have not as yet met, but it has been described. It might of course be due to some fault of asepsis ; but in the absence of this, infection from the interior of the pylorus is the probable cause. Whether infection can spread through the unprotected but intact mucous membrane is open to question, but the early covering of the bare area by blood-clot, as seen post mortem, renders it unlikely, and the same would apply to a microscopic injury of the mucous membrane. A macroscopic wound was demonstrated by a bubble on squeezing the stomach in one of my cases ; this was closed by a fine catgut suture, and no unfavourable symptom followed, a result tending to justify the confidence just expressed in the efficacy of the protecting clot. Such a wound of the mucous membrane, if undetected and left open, could easily allow leakage, and should therefore be looked for with great care, especially at the duodenal end of the incision where the danger is greatest.

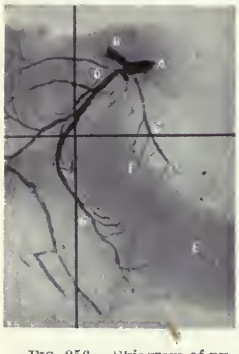

FIG. 256.—Skiagram of pylorus of infant with injected arteries. A, Cœliac axis B, Hepatic artery. C, Pyloric artery. D, Gastroduodenal artery. E, Stomach F, Pylorus. G, Right gastro-epiploic artery.

Diarrhœa. — Diarrhœa, sooner or later accompanied by vomiting, is unfortunately not infrequent, and may easily be fatal. Once established, the prognosis of the case is extremely grave, especially when the complication arises soon after the operation before the patient's general condition has had time to improve. It is therefore of great importance that the condition be prevented, and that the factors causing it be eliminated as far as possible. In my opinion there are two factors responsible for the onset of diarrhœa. The intestine of such an infant in its short life before the operation has not exercised its full normal function, since normal quantities of food have not passed out of the stomach, and it seems reasonable to suppose that the intestinal mucous membrane is more susceptible to irritation than in the case of a normal infant, and has acquired very little immunity to the cause of infective diarrhœa. Added to this predisposing susceptibility, irritation itself acts as an exciting cause, and the question of the origin of such irritation therefore arises.

In those cases in which obstruction of the pylorus is not complete, instead of the classical constipation, slight diarrhœa may be present before operation, the stools being green and liquid, although small in size and containing little food ; this condition can be explained by spread of inflammation from the gastric mucous membrane to the intestine. In such a case the additional quantity of food passing through the pylorus after operation may not be dealt with normally, and diarrhœa may become severe. In one of my cases (*Case* 10) in which such incomplete obstruction existed, the operation stopped the vomiting, and the child did well till the fourth day, when the temperature rose suddenly and a large green stool was the beginning of continued diarrhœa accompanied by vomiting and leading to exhaustion and death on the seventh day. When even slight diarrhœa is present before the operation, it is very difficult to treat, since the child is not fit to be deprived of food, and the constricted pylorus maintains the unsatisfactory state of the stomach and prevents efficient administration of drugs. In such a case the stomach should be treated by thorough washing out, and the greatest possible caution exercised in feeding both before and after the operation. With a view to finding whether there is present in the stomach contents before operation any abnormal micro-organism which might be responsible for the intestinal infection, Dr. M. H. Gordon has

examined for me the washings from such a stomach and has found only the *Streptococcus salivarius*, an organism which is also found in the stomach of a normal infant.

In those cases in which there is no diarrhœa present before operation I consider the complication, when it arises, to be due to infection from without. It occurs much more frequently in hospital, where patients—usually in a more serious condition when first seen—are in wards with other infants, than in private cases where they can be completely isolated. As an example, I may quote one of my cases (*Case* 9), which fortunately was a success in the end, in which the patient suffered during convalescence from three attacks of diarrhœa, each coinciding with the admission to the ward of a case of acute diarrhœa and vomiting.

As regards prevention, breast feeding suggests itself as the obviously ideal method of post-operative treatment. Unfortunately this is usually impossible, since various artificial foods have already been tried in most cases, and the mother's milk is no longer available. One has, therefore, to be content with isolating the child as far as possible and paying the most scrupulous attention to the preparation of the food and to the care of utensils. Should diarrhœa start, in spite of precautions, general methods of treatment must be adopted; but unfortunately these are frequently unsuccessful.

Post-operative Fever.—Another complication which may cause a fatal result is hyperpyrexia. It has been noted that in cases operated upon by Rammstedt's method the temperature at once rises sharply, usually not higher than 101° to 103°, and falls again in from twenty-four to forty-eight hours. Sometimes, however, the fever is much higher, reaching 107° or 108°, and cannot be reduced even by vigorous treatment, so that death follows rapidly.

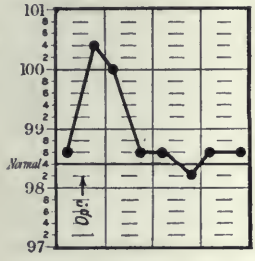

FIG. 257.

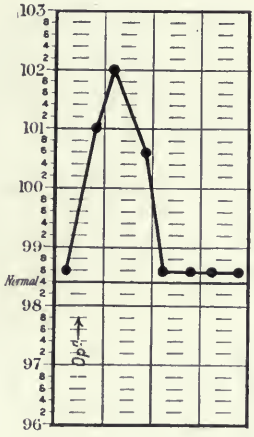

FIG. 258.

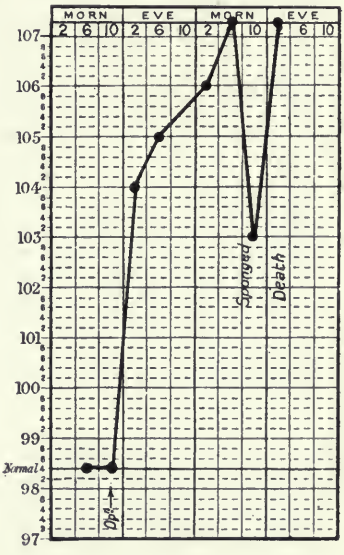

FIG. 259.

It is well known that the heat-regulating mechanism of infants is easily disturbed, and that this instability is increased in undeveloped, wasted, or exhausted patients. One would also expect that the susceptibility to irregular temperature would be in proportion to the degree of wasting and exhaustion present. A partial explanation offers itself in the lack of body fluids and consequent diminished perspiration. In all my cases, with the exception of one to be mentioned later, a post-operative rise of temperature occurred (*Figs.* 257 and 258); this was not excessive, soon fell, and had no unfavourable result except in one case (*Case* 6) in which, in spite of energetic measures, the temperature rose to 108° and the child died in convulsions twenty-six hours after operation (*Fig.* 259). This infant was much older than my other patients, being sixteen weeks of age, having been under medical treatment for seven weeks and weighing only 7 lb. at the time of operation.

I consider that in these wasted infants, so susceptible to irregular fever, the same

factor is responsible for the onset of pyrexia as for diarrhœa, when that complication occurs. The intestine is unused to food, and its resistance to extraneous substances such as food, and its absorptive powers, are not normal ; thus it seems possible that the sudden influx of food in an unaccustomed quantity may, by local irritation and abnormal absorption, initiate a rise of temperature which can easily become uncontrollable on account of the unsatisfactory general state of the patient. In my *Case* 8 there was no post-operative rise of temperature, but symptoms were not relieved, vomiting continued, and the child did not improve ; on the fifth day the abdomen was re-opened and, as will be described later, the obstruction was found to be unrelieved. A more satisfactory incision was made in the pylorus, and the abdomen closed ; symptoms ceased, and the child recovered ; but the interesting point is that after the second operation the typical rise of temperature occurred (*Fig.* 260). This case, if it does not prove the theory given above, at least suggests that the passage of food into the intestine has some influence on the post-operative temperature.

Regarding the treatment of post-operative fever, in ordinary cases nothing is necessary except to prevent too great a rise by giving sufficient air and plenty of fluid, and to see that the child is not too heavily covered. In cases in which the temperature rises to 104° or more, sponging, ice to the head, and enemata of iced water should be tried ; but hyperpyrexia, when once established, is a stubborn and usually fatal condition.

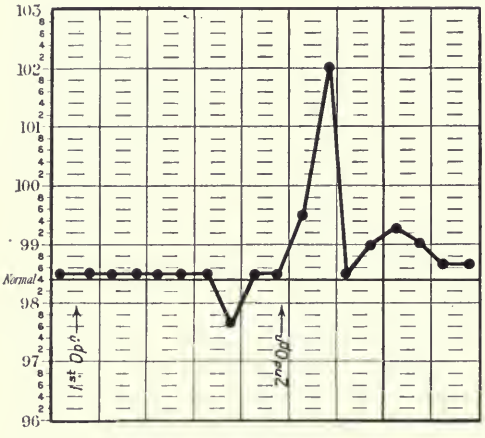

FIG. 260.

The two complications just described, diarrhœa and high fever, are the most frequent causes of death after Rammstedt's operation, and have therefore been discussed in detail. As will be seen, I consider both to be due primarily to the atrophied condition of the intestine consequent upon partial or complete starvation ; the longer such starvation has continued the greater the risk, and this is one of the main reasons for urging that no time be lost before undertaking surgical treatment in those cases in which medical methods do not show early signs of success.

Recurrence of Symptoms.—A final complication that must be mentioned is recurrence of symptoms due to insufficient division of the constricting muscular band. It is suspected if typical vomiting does not cease immediately after the operation ; a few small vomits after the anæsthetic may occur and, as in any baby, small regurgitations may be frequent ; also vomiting may take place on moving the patient, or after an increase in feeding ; but there should be no large projectile vomits of collected food. Should such occur and continue, it is probable that some part of the constriction still exists and, while washing out may be tried for a short time, a second operation should not be delayed.

Tyrrell Gray[2] describes a case in which a constriction at the gastric end of the pyloric incision was responsible for continued symptoms. Cases have occurred in which only the middle of the muscular band was divided, leaving a constriction at each end between which the mucous membrane bulged like a hernia. In my own *Case* 8, already mentioned, the second operation showed that the edges of the incision in the muscle had met and were united by organizing lymph ; fortunately, re-opening and lengthening of the original incision resulted in cure. I am unable to explain what had happened in my case of recurrence ; the muscle usually retracts widely and the mucous membrane bulges freely, and at the first operation nothing unusual was noticed ; possibly some fibres at the bottom of the incision and part of the constricting band at its ends were not divided ; the child was only three weeks old, not greatly wasted, and the undivided fibres may

TABLE OF THE TEN CASES OF RAMMSTEDT'S OPERATION UPON WHICH THE AUTHOR'S PAPER IS BASED.

Case	Sex	Weight at Birth	Age, First Symptoms	Place	Previous Treatment	Age at Operation	Weight at Operation	Character of Pylorus	Progress	Result
No. 1 E. S.	F.	lb. oz. ?	2 weeks	Hospital	Four weeks' lavage and feeding in hospital, with no improvement and loss of weight	9½ weeks	lb. oz. 6 5½	Large and white	No vomiting, but no gain in weight	Died suddenly 7th day
No. 2 A. A.	M.	8 7	2½ weeks	Hospital	Four days in hospital. Lavage and feeding, with rapid loss of weight	5 weeks	6 13½	Large and white	Recovery only interrupted by an attack of influenza 1 month after operation	Cured
No. 3 D. T.	F.	?	3½ weeks	Hospital	Two days in hospital. Lavage and feeding. No improvement	8½ weeks	5 2	Large and white	No vomiting. Fourteen days' rapid improvement and gain of 10 oz. Then diarrhœa and vomiting, which continued	Died 4½ weeks after operation
No. 4 C. R.	F.	7 0	7 weeks	Private	Four weeks' careful diet. Lost weight from 10 lb. at 7 weeks	12 weeks	6 14	Large and white	Uninterrupted recovery	Cured
No. 5 J. Y.	M.	7 8	10 days	Private	Three weeks' careful diet, with continued loss of weight	5 weeks	6 5	Small and vascular	Uninterrupted recovery	Cured
No. 6 D. D.	M.	9 0	10 days	Private	Seven weeks' careful diet and lavage, with no continued improvement	16 weeks	7 0	Small and vascular	Temperature rose to 105° in 12 hours and to 108° in 20 hours. Convulsions. No vomiting	Died after 26 hours
No. 7 C. E.	M.	9 0	2 weeks	Hospital	Two days' lavage and feeding in hospital. No improvement	5 weeks	8 6	Large and white	Diarrhœa and vomiting with fever began on 4th day and continued	Died 17th day
No. 8 J. N.	M.	7 8	2 weeks	Private	Careful diet and lavage 1 week. Continued to lose weight	3 weeks	6 4	Large and white	Vomiting did not cease. Abdomen re-opened and pyloric incision enlarged on 5th day. Uninterrupted recovery	Cured
No. 9 L. J.	M.	?	3 weeks	Hospital	Careful diet and lavage in hospital 2 weeks. Atropine tried but unsuccessful. Continued vomiting and loss of weight	6 weeks	6 7	Thin and vascular	Three attacks of diarrhœa and vomiting, but final recovery	Cured
No. 10 J. W.	F.	5 5	5 weeks	Hospital	Careful diet and lavage in hospital 3 weeks. Continued vomiting and loss of weight from 6 lb. 8 oz on admission. Had slight diarrhœa before operation	10 weeks	5 15	Large and white	No vomiting after operation. Fourth day large green stools and fever. Diarrhœa continued	Died 7th day

have been sufficient to bring the edges of the incision near enough to each other for union to have taken place. Great attention should be paid, therefore, to complete division of the hypertrophied band of muscle at its extremities and at its deepest part ; further, the muscle should be separated, by blunt dissection at each side of the incision, from the underlying mucous membrane, ensuring the bulging of the latter into the gap.

The table on page 407 comprises the ten cases upon which this paper is based. Five died, but none were fatal from the shock which was a frequent termination after the older operations. Although the total number is small, the 50 per cent mortality is a reduction on the usual older figures, and it is hoped that the frequency of success will increase as the cause and means of prevention of serious complications become better known.

The details of technique and the various post-operative complications of Rammstedt's operation have now been discussed, and it is seen that although the operation itself is simple, and attains its object of re-establishing the pyloric canal without at once killing the patient, these complications are of a serious nature, and, until they are thoroughly understood and methods for their avoidance and cure discovered, the final mortality of the procedure will not be as low as could be desired, although it already shows a great improvement on that of the earlier methods of surgical treatment in most hands.

As has already been said, medical treatment would be the ideal, but the very diversity of opinions and theories regarding the cause and treatment of the condition shows that these are not yet clear. In each case different factors predominate, and it is only by collecting all the facts and opinions that in time the true explanation will emerge ; it is partly in the hope of adding something, however little, to the knowledge of the subject that the observations and views contained in this paper are put forward.

But while waiting for the ideal treatment to be discovered, patients suffering from congenital pyloric stenosis must be treated by the methods we already possess, and a certain varying proportion will require operation. The chief object therefore of this paper is once more to express the opinion that Rammstedt's is the operation of choice, and that its performance should not be delayed, for the reasons given above, in cases in which medical treatment is unsuccessful ; and also to give the writer's personal experience of the operation from all aspects in the hope that it may be of some value to others, and possibly add to the general knowledge of a procedure which has its undoubted value as part of a large and interesting subject.

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THE DEVELOPMENT OF CYSTS IN CONNECTION WITH THE EXTERNAL SEMILUNAR CARTILAGE OF THE KNEE-JOINT.

By ROBERT OLLERENSHAW, Manchester.

In my work in the orthopædic department of Salford Royal Hospital I have now met with three instances in which cystic changes had occurred in the external semilunar cartilage. The condition has been recorded previously by several German observers. In 1904 Ebner[1] reported one case in great detail; in 1906 Schmidt[2] recorded a case, and in 1915 Riedel[3] described 6 cases upon which he had operated. Eden[4] also reported 2 cases in 1911. In 1909 Mr. Furnivall, who was then a member of the honorary staff of the London Hospital, told me of a recent example and referred to another case with which he had dealt. He presented a specimen to the museum of the Royal College of Surgeons. I have examined this specimen, which shows precisely the same condition as is seen in my own cases.

The museum catalogue describes it as follows: "The chief portion of a right semilunar cartilage removed by operation from the knee-joint. Projecting from the outer attached border there is a somewhat hemispherical swelling which extends for about half an inch along the cartilage and attains a maximum eminence of half an inch. As seen in the divided surfaces, the swelling consists of a series of well-defined spaces which, in the recent state, were filled with a thick, transparent, mucoid material. The smallest spaces appear as clefts between the bundles of white fibrous tissue at the periphery of the fibrocartilage, and seem to have arisen from a mucoid softening of the tissues and not in any way to be connected with the attached portions of synovial membrane. From a man, age 30, who slipped and fell, injuring the right knee four months before coming under observation. About a month later he noticed a swelling on the outer side of the joint; this slowly increased and troubled him in walking; it was especially uncomfortable at night and in the morning, without ever causing actual pain. On examination, there was found a swelling as large as a small filbert over the region of the external semilunar cartilage, just in front of the external lateral ligament: it was fixed to, and moved with, the tibia, and was unaffected by contraction of the biceps. The movements of the joint were smooth, and the other structures of the knee were normal. There was no affection of any other joint, and there was no history of gout or rheumatism. The parts shown were removed by longitudinal incision over the swelling.

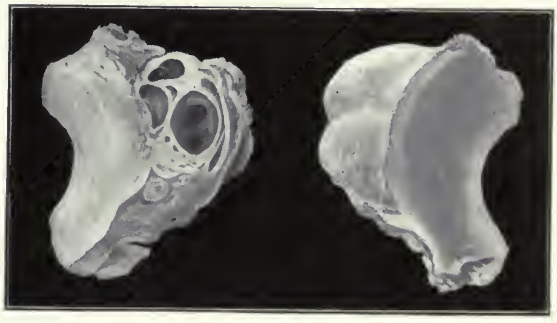

Fig. 261.—Specimen in R.C.S. Museum.

"The swelling was wholly inside the capsule of the joint. The wound healed by first intention, and the function of the joint was afterwards perfect."

Fig. 261 shows a drawing which Mr. Sewell has made of this specimen. The clinical history of all the cases seems to be similar; all have a history of an injury, usually not severe, with gradually increasing pain and lameness, and with the development of

a swelling over the external cartilage about the junction of its anterior and middle thirds. The swelling is rounded, and varies in size from a half to one inch in diameter. It is tense but distinctly fluctuant. *Fig.* 262 is a drawing from a photograph of one of the cases, and shows the appearance and position of the tumour very well.

My first patient, a man, age 40, had been operated upon eighteen months previously because of pain in the knee and the localized swelling. The cyst alone was removed. Six months later the swelling and pain recurred. A scar of an oblique incision over the anterior part of the cartilage was present. At operation I found that the cyst wall was adherent to the skin scar of the first operation, and my incision opened up the cyst, from which a clear glycerin-like fluid escaped. I excised the whole cartilage with the cyst.

FIG. 262.

The second and third cases, men of 20 and 26 years, showed the same clinical picture, except that they had not been operated upon before, and in both of them the cartilage was removed with the cysts intact. The after-progress of all three cases was quite uneventful, and all recovered full function with freedom from any discomfort. *Figs.* 263, 264, 265, and 266 illustrate the specimens removed from these men.

As to the pathology of the condition, I supposed at first that the cysts were probably the end-result of hæmorrhage or were produced by myxomatous degeneration of cartilage consequent on the trauma. Macroscopically the cysts are multilocular and appear to develop in the substance of the fibrocartilage near its outer border. They gradually enlarge and, taking the line of least resistance, project on the outer side. The lining is smooth and shining, and the contents are a clear mucoid material. Sections of the cartilage and cysts show, microscopically, a distinct lining to the cysts. The lining is a flattened endothelium similar to the synovial membrane endothelium. The presence of this endothelial lining is entirely opposed to the idea of a degeneration cyst or a cyst following on a hæmorrhage. In the drawing of the specimen shown in *Fig.* 263, the large cystic spaces are well shown. In the section of the cartilage itself, immediately below the cyst, a small space in the actual cartilage is to be seen. This appears to be an early cyst in the process of distention. *Fig.* 266 shows a large cyst occupying nearly the whole of the transverse section of the cartilage. This was part of the specimen taken from my first case, which had been operated upon eighteen months previously, and in which a recurrence had taken place. *Fig.* 267 illustrates

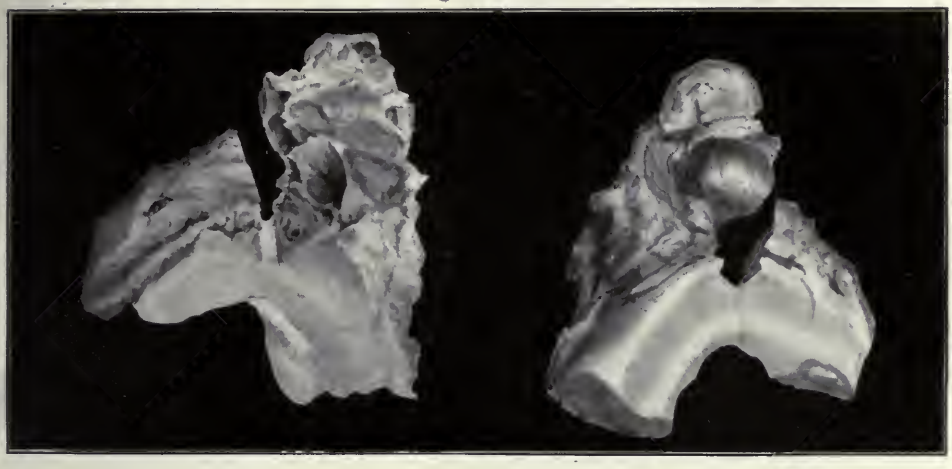

FIG. 263.—Specimen removed from second case. Note the small cyst developing in the cut surface of the fibrocartilage.

FIG. 264.—Specimen from third case.

FIG. 265.—Specimen from third case.

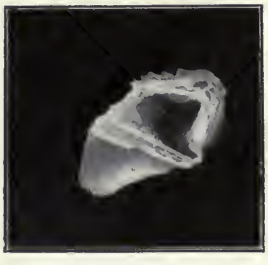

FIG. 266.—From first case. Showing a large cystic space completely surrounded by fibrocartilage.

the microscopical appearance of the cyst wall; the endothelial lining, with its nuclei, is well shown.

Ebner states that the cysts in his case showed no evidence of endothelial lining. Endarteritis of vessels in the surrounding connective tissue was present, though whether as a result of trauma or of pressure from the cysts he could not decide. In his case a yellow colour in the cartilage suggested degenerative changes. Schmidt found no endothelial lining in his specimen and no vascular changes. His case is particularly interesting, because he operated upon it three times before finally removing the cartilage. At the first and second operations he removed the cysts alone, and recurrences followed in four and six months.

Riedel had two recurrences in cases in which he simply removed the cysts. He remarks that in the case of wrist ganglia spontaneous disappearance is not infrequent, but that such an occurrence has never been recorded in the case of cysts connected with the knee cartilage.

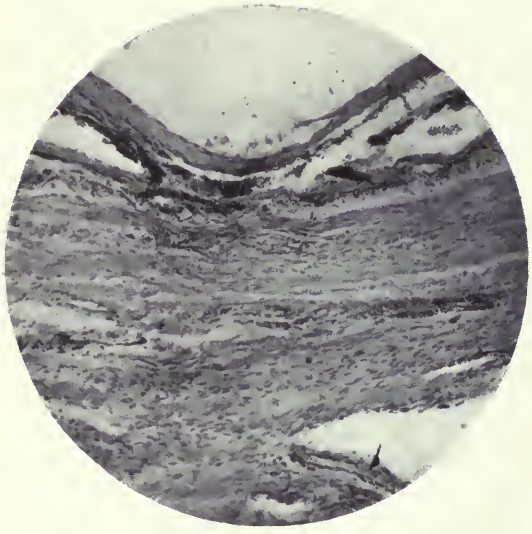

FIG. 267.—Microphotograph of the cyst wall, showing endothelium. (*From the Pathological Department, Salford Royal Hospital. Dr. C. E. Jenkins.*)

In spite of this, Schmidt classifies these cysts as ganglia, defining a ganglion as a cyst formed by the softening of para-articular, tendinous, or periosteal tissues caused by colloid degeneration consequent on deficiency in nutrition following trauma. Riedel also refers to a case of Haehnel in which two operations for removal of cysts were each followed by recurrence, and a third for removal of the cyst-bearing cartilage effected a cure.

My own view is that the cysts are developmental in origin, due to small endothelial inclusions in the cartilage during its development, and that trauma causes an irritation and a distention of the spaces. In the knee-joint the semilunar cartilages are developed in folds of synovial membrane which are derived from the interchondral disc, and it is not difficult to imagine that in the disappearance of the interchondral disc and its replacement by joint-cavity, capsule, and synovial membrane, small inclusions may occur in the folds of membrane in which the semilunar cartilages are ultimately developed. The lesion has occurred in the external cartilage in all of my three cases. It was also in the external cartilage in all the other reported cases. The explanation of this fact I am unable to determine. No instance of its occurrence in the internal cartilage has been reported. If trauma is a causative factor, it seems extraordinary that the inner cartilage, which is so frequently injured, should not be the seat of the lesion on most occasions. The pathological condition is obscure and interesting, and from the point of view of treatment the most important fact is that local removal of the cyst is frequently followed by recurrence, and that only a complete removal of the cyst-bearing cartilage provides a permanent cure.

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ON A FURTHER SERIES OF 500 GOITRE OPERATIONS, WITH SPECIAL REFERENCE TO AFTER-RESULTS.

By JAMES BERRY, London.

A paper delivered before the Surgical Section of the Royal Society of Medicine, Jan. 5, 1921.

It is, in my opinion, the duty of every surgeon who enjoys unusual opportunities of performing large numbers of any particular surgical operation, to publish from time to time details of his cases with, so far as he can, an accurate record of his results, both immediate and remote. Any complications that have occurred, any improvement or alteration in his practice, any mistake that has been made—in short, any lesson that he has learnt from the study of his cases—should be made available for the benefit of others who have to deal with similar cases.

In the following pages I propose to give, as far as space will allow me, an account of all the cases in which I have removed any portion of the thyroid gland during the period from Jan. 1, 1913, to Dec. 31, 1919. These operations, five hundred in number (Nos. 752–1251),* form a direct continuation of previous series which have been already published elsewhere.†

The 87 operations which I have performed from the beginning of 1920 up to the present time, being too recent for my present purpose, have not been included in this series, although I make use of one or two of these to illustrate special points.‡ On the other hand, 24 cases of operation for exophthalmic goitre performed during 1913 and already published in detail in the British Journal of Surgery§ are necessarily included in the present series.

I. SEX AND AGE INCIDENCE.

Table I.—Sex and Age Incidence of the Series of 500 Cases (No. 752–1251 inclusive‖).

Males		Females	
15–19 years inclusive 6		14–19 years inclusive 26	
20–29 ,, ,, ... 12		20–29 ,, ,, ... 95	
30–39 ,, ,, ... 8		30–39 ,, ,, ... 139	
40–49 ,, ,, ... 10		40–49 ,, ,, ... 119	
50–59 ,, ,, ... 16		50–59 ,, ,, ... 45	
60–69 ,, ,, ... 4		60–69 ,, ,, ... 13	
70–75 ,, ,, ... 7		70 and over 0	
Total males 63		Total females 437	

The youngest patients were five girls aged 14, the subjects of parenchymatous goitre, rapidly growing, causing dyspnœa, and failing to respond to medical treatment. In all

* Performed upon 496 patients: one malignant, one exophthalmic, and two others having been operated upon twice.

† *Proc. Roy. Soc. Med.*, 1907, Dec.; *Trans. Med. Soc. Lond.* vol. xxxvi; *Lancet*, 1913, March; and elsewhere.

‡ The figures used to illustrate this paper are also, in some instances, taken from cases before or after the present series, as will be seen from the accompanying reference numbers. Owing to war troubles (want of preserving fluid and jars, and other reasons), a large number of the actual specimens of this series, including some of the most important, were thrown away without my knowledge.

§ *Brit. Jour. Surg.*, 1914, i, No. 4, p. 699.

‖ These numbers refer to operations for the removal of goitre, and form part of a consecutive series from the year 1888, when No. 1 was performed.

FIG. 268.—No. 1776. Parenchymatous goitre causing dyspnœa. F., age 14. Resection-extirpation of R. lobe. Weight of portion removed 7 oz.

The oldest female patient in this series was a lady, age 66, with dyspnœa and tachycardia, from whom an old, partly calcified, adenoparenchymatous goitre weighing 4 oz. was removed, with complete relief.

Among the male patients, seven were 70 years of age or over; all made good recoveries; in most of these the tumours were large and unilateral, with much displacement of the trachea and larynx. One of these patients, age 74, had first consulted me thirteen years previously on account of a cystic tumour as large as an orange, but had postponed operation until a huge tumour occupied the whole of the right side of the neck, displacing the larynx and trachea so much that he had had alarming attacks of suffocation, which drove him to operation. The thick-walled cyst, which was removed without difficulty, cases the goitre was of considerable size: in one the portion removed weighed 11¼ oz.; all made good recoveries and are quite well now.

Operations in children below the age of puberty are hardly ever necessary, and on account of the danger of interfering with subsequent growth and nutrition they should never be undertaken except for some very urgent reason. Operations for mere deformity in children are in my opinion quite unjustifiable. On the other hand, parenchymatous goitres at or about the age of puberty and later, if growing rapidly and causing really serious stridor and dyspnœa, often urgently demand operation if they do not yield to medical treatment. The trachea in such cases is so soft that it can easily be fatally occluded by a double goitre, especially if the lower part of the latter be situated low down behind the sternum, as it so often is.

The youngest among the male patients were two boys, age 15; the cases were exactly similar to the preceding.

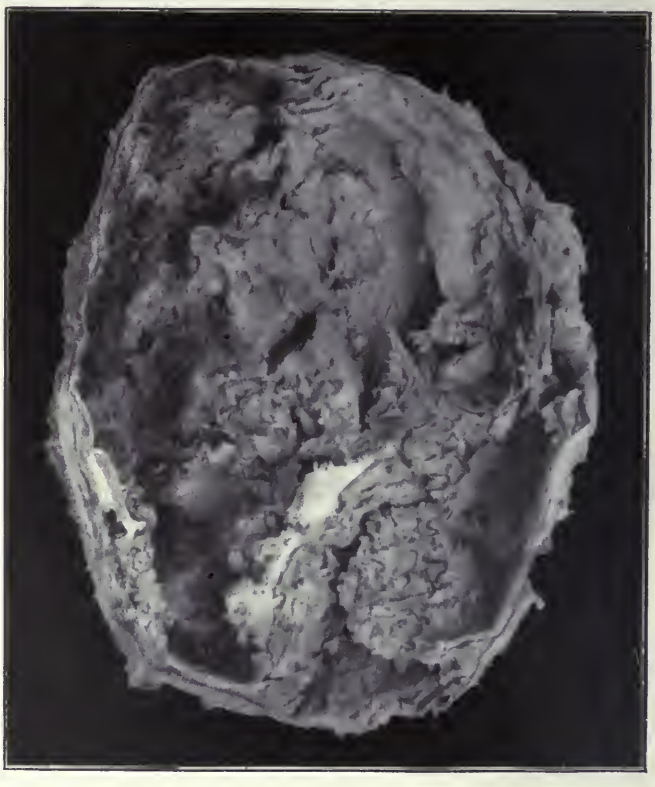

FIG. 269.—No. 103. Old cystic adenoma with thick fibrous and calcified wall. Interior was filled with broken-down blood-clot and colloid. Removed from a doctor, age 60. (*R. Free Hosp. Mus.*—xxii. 48.)

FIG. 270.—No. 1306. Parenchymatous goitre causing dyspnœa. M., age 13. R. lobe and about two-thirds of L. removed. Weight 8¾ oz.

FIG. 271.—No. 1313. Portion of a parenchymatous goitre causing dyspnœa. F., age 14½. Extirpation of R. and lower half of L. lobes. Weight 6½ oz. Shows commencing fibrosis and much reduction of colloid from prolonged previous medical treatment.

contained a pint of brown, porridge-like material, a mixture of colloid and old blood-clot with much cholesterin.

The oldest patient of the series, a minister, age 75, was operated upon nearly five years ago for a retroclavicular goitre causing much stridor and dyspnœa. The tumour weighed over half a pound. The patient is now hale and hearty at 80. Another patient, a man of 73, with a solid, largely calcified, adenomatous mass of many years' duration, weighing 22¼ oz., is in excellent health at the age of 80. His wound healed per primam, the highest temperature after operation having been 99·8°.

The removal by resection-enucleation of these large prominent unilateral tumours in old people is, in my experience, a very satisfactory operation. The tumours are often old tough-walled cysts ; the removal involves but little interference with the thyroid gland tissue itself ; the vessels are usually very easily secured ; provided the strictest attention be paid to asepsis, to the complete arrest of all hæmorrhage—even the most trifling oozing —and the wound be drained for at least a few hours, the results are very satisfactory.

II. PROPORTION OF HOSPITAL TO PRIVATE CASES.

Table II.

Hospital cases	Male	29		
	Female	227		
			—	256
Private „	Male	34		
	Female	210		
			—	244
	Total			500

It will be seen from the above table that the number of hospital and private patients were about equal, nor was there, on the whole, much difference between the severity of the cases in the two classes. Only among the exophthalmic goitres did the hospital cases (50) considerably exceed the private (29), doubtless owing to the fact that hospital patients are less able to afford prolonged rest and medical treatment, and therefore come earlier and more readily to operation.

III. NATURE OF THE GOITRE.

Table III.

Encapsuled :—			
Solid adenoma	88		
Cystic „	109		
Pure cyst	1		
		—	198
Non-encapsuled :—			
Parenchymatous	70		
Adenoparenchymatous	137		
Inflammation (acute or chronic)	3		
True exophthalmic	79		
Malignant and papilliferous	13		
		—	302
	Total		500

It may be admitted at once that the above classification is, pathologically, not strictly accurate ; but it is convenient clinically. The term parenchymatous used here for the uniform enlargement of the gland with distention of all the vesicles—the commonest goitre of young people—is a well-established term difficult to replace by any more exact, and pathologically more correct, expression.

The term adenoparenchymatous is used loosely for the more lobulated, and often nodular, goitres of middle-aged and elderly people in which, embedded in the midst of parenchymatous goitre-tissue, there are encapsuled masses of atypical thyroid tissue, sometimes solid, but often breaking down into cysts. Sometimes these masses are true adenomata, more often they are not.

FIG. 272, *a* and *b*.—No. 1238. (*a*) Parenchymatous goitre, 30 years' duration, with some adenomata, (*b*) Side view. Treated by bilateral resection-extirpation. Nine-tenths of R. lobe three-quarters of L. Weight 22 oz.

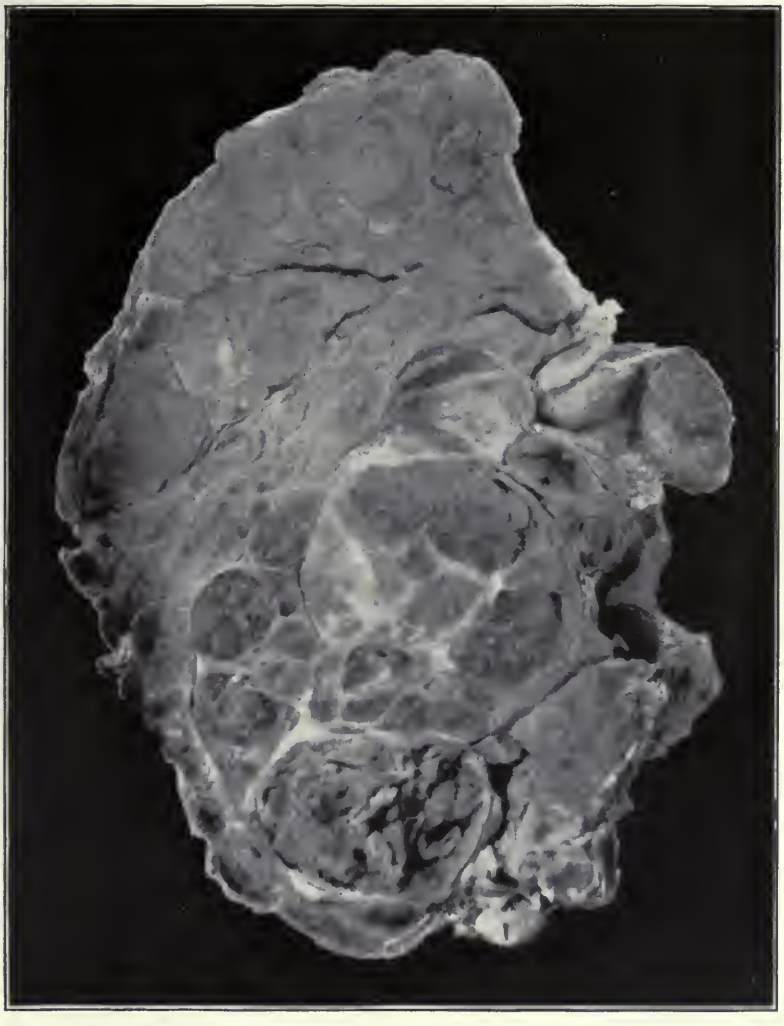

FIG. 273.—Section of part of the above. (*Photos by Miss G. Matthews.*)

FIG. 274, *a* and *b*.—No. 993. (*a*) Adenoparenchymatous goitre causing dyspnœa and considerable distention of veins at root of neck. F., age 27. (*b*) Side view. Extirpation of R. lobe. Weight 12¼ oz. Six years later remaining lobe had enlarged considerably.

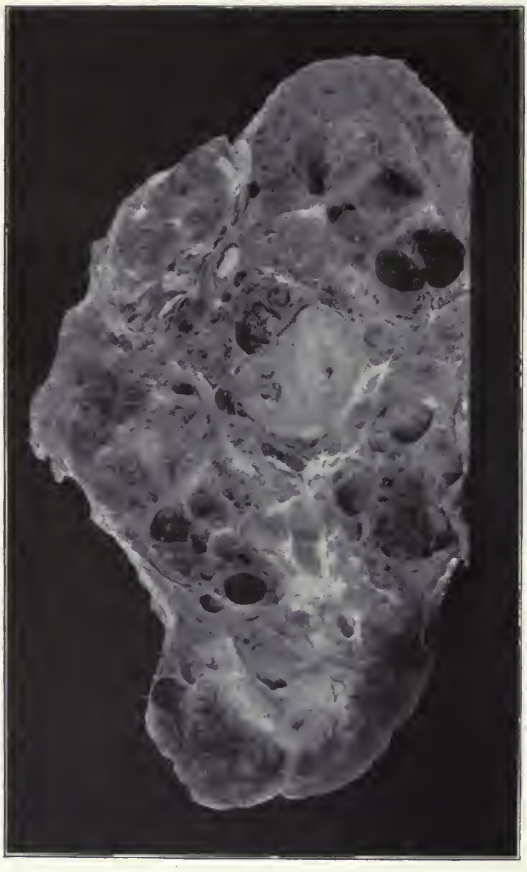

FIG. 275.—Section through goitre removed from preceding. Lobulation and fibrosis more advanced than in *Fig.* 271, No. 1313. Solid adenomatous masses in various parts.

Pure cyst is a term used for a single cyst with smooth lining like a hydrocele, a somewhat rare condition compared with the much more common form of cyst which is formed by the breaking down of a previously solid encapsuled adenoma, the remains of which can generally be seen adhering to the interior of the cyst wall. The distinction is clinically of some importance, since it is the soft vascular tissue in the interior of the common thyroid cystic adenoma that is so likely to give rise to intracystic hæmorrhage, occurring spontaneously or after slight injury.

FIG. 276.—No. 948. Adenoparenchymatous goitre causing dyspnœa. F., age 37. Bilateral resection-extirpation. Weight 18 oz.

FIG. 277, *a* and *b*.—No. 989. (*a*) Old parenchymatous goitre causing dyspnœa. M., age 50. (*b*) Side view. Extirpation of most of L. and lower half of R. lobe. Weight 8¾ oz.

In a large number of the encapsuled tumours removed there was abundant evidence of recent or old hæmorrhage having occurred before operation. But this very rarely occurs in parenchymatous goitre.

It is usually quite easy to make a differential diagnosis between encapsuled and non-encapsuled thyroid tumours, a matter of much importance as regards the question of operation. On the other hand, to say definitely that an encapsuled tumour is wholly cystic or wholly solid, or partly one and partly the other, is usually impossible; but from the point of view of operative interference this is a matter of comparatively little importance, since both have to be treated in a similar manner.

The three cases of inflammation are of sufficient interest to be given in detail.

Case 1.—A suppurating cyst as large as a small walnut in a lady, age 37 ; only a few days prior to operation she had first noticed a smooth, hard, movable swelling in the neck, the most prominent feature being pain. On removal it proved to be an old cystic adenoma containing thin purulent fluid ; the tumour was freely removed, the wound drained for two days, and a rapid recovery ensued. Two and a half years later she wrote to say that she had been quite well ever since.

Case 2.—A married lady, age 36, who had had a rounded lump in the neck for about two years. It was about as large as a pigeon's egg, and as she gave a history of its having varied a good deal in size, it was thought to be an ordinary cystic adenoma. As it was not causing any trouble, I at first advised against any operation ; but as she came back later complaining of a

FIG. 278.—No. 262. Adenoparenchymatous goitre removed for dyspnœa. At upper pole is a well-encapsuled cystic adenoma. F., age 42. Weight 6 oz.

good deal of pain, the tumour was removed. It proved to be a solid, non-encapsuled mass involving the whole of the left thyroid lobe, which was removed. It consisted almost entirely of chronic inflammatory tissue of a pale yellowish colour, without colloid and without any evidence of actual suppuration.

The wound healed apparently per primam, and she left the home at the end of a week. Subsequently suppuration occurred and the wound had to be reopened on two occasions ; it did not finally heal until two months after the operation.

In neither of these cases was the cause of the inflammation clearly ascertained.

Case 3.—This case was that of a lady doctor, age about 46, who underwent removal of the right thyroid lobe for what was probably an early stage of so-called 'cancériform' primary chronic inflammation (Riedel's disease). The patient came complaining of a painful lump in the neck of two months' duration. It was obviously thyroid, and not much larger than a hazel-nut. It was hard and knobby, and did not move quite so freely upon the larynx as an ordinary innocent tumour of the thyroid should. There was no dyspnœa, dysphonia, or dysphagia, and the only

symptom was a certain amount of pain on both sides of the neck. It was thought to be probably a small cyst in the middle of an old and hitherto unnoticed goitre, especially as two other members of her family were known to have goitres. But in view of the serious possibility of the case being one of early malignancy, the right lobe was removed, the operation presenting no difficulty of any kind.

The pathological report (by Dr. Helen Chambers) was: "The outer surface is smooth and somewhat white and opaque. On section, the tissue is white and firm and contains numerous white, narrow, fibrous strands passing through it in all directions. No colloid can be seen. The macroscopic appearance suggests a chronic inflammatory condition of the thyroid gland. On

FIG. 279 *a* and *b*.—No. 1261. (*a*) Adenoparenchymatous goitre, 28 years' duration. (*b*) Side view. Bilateral resection-extirpation for bulk, deformity, and dyspnœa. F., age 48. Weight 19 oz. (*Photos. by Miss B. Rickard.*)

FIG. 280 *c*.—The same patient as in *Fig.* 279, one year after operation.

microscopic examination no normal tissue can be found. The section shows chronic inflammatory changes, and it is certainly not a malignant growth. . . . . The cause of the inflammatory condition is not evident".

The opposite lobe appeared to be quite healthy. The wound healed at once. Five months later the patient wrote that she had been quite well ever since the operation. Three weeks ago (6½ years after the operation) she wrote from abroad that her "health has been and is excellent", and that there is no sign of any recurrence. She adds the interesting note that a sister of hers who had had a goitre since childhood has recently died of malignant disease of the thyroid.

True Exophthalmic Goitre.—In this class (79 operations on 78 patients) have been placed only those cases in which not only the clinical symptoms, but also the naked-eye

FIG. 281.—Section through right lobe of No. 1261, showing much old fibrosis,

FIG. 282.—Section through left lobe of No. 1261, showing a large cavity which contained broken-down blood-clot and colloid.

FIG. 283, *a* and *b*.—No. 867. F., age 25. (*a*) Typical exophthalmic goitre, 4 years' duration. (*b*) Side view. Treated by extirpation of right lobe.

and microscopic appearances of the disease, were quite characteristic. There was, however, one doubtful exception in which for some unexplained reason the pathological report received apparently failed to confirm the clinical diagnosis, which appeared to admit of no reasonable doubt.

FIG 284.—Nos. 1029 and 1315. Typical exophthalmic goitre removed from lady, age 29. Weight 4 oz.

FIG. 285.—No. 1265. Part of a papilliferous carcinoma removed from a man, age 57. (*R. Free Hosp. Mus.—Ea. Pb.* 402.)

Cases of 'false' exophthalmic goitre, that is, of tachycardia, tremor, etc., without exophthalmos, and mostly with unilateral tumours, have been rigidly excluded from this class. In some of these cases, the apparent symptoms of Graves' disease, especially the palpitation and tachycardia, would appear to have been caused by long-continued and excessive administration of thyroid-gland preparations. The inclusion of such cases among those of true exophthalmic would be, in my opinion, quite misleading, although it is often done.

FIG. 286.—No. 1140. Spheroidal-celled carcinoma removed from F., age 65. (*R. Free Hosp. Mus.—Ea. Rb.* 426.)

Malignant and Papilliferous.—This group of 12 patients (13 operations, one patient with papilliferous carcinoma having been operated upon twice within the period) includes tumours of very different degrees of malignancy, from papilliferous carcinoma and one endothelioma, with histories extending over several years, to a suppurating sarcoma with a total duration of six months. Two were sarcomata, one was not definitely determined, and the rest were carcinomata.

IV. PRINCIPAL REASONS FOR OPERATION.

Table IV.

Dyspnœa	274	of which 1	died
Discomfort, deformity, and slight dyspnœa	99	„ 0	„
Deformity	17	„ 0	„
True exophthalmic goitre	79	„ 3	„
Malignant and papilliferous	13	„ 2	„
Suspected malignancy	5	„ 0	„
Primary chronic inflammation	1	„ 0	„
Palpitation, nervousness, etc.	12	„ 1	„ (glycosuria)
Total	500		

Dyspnœa.—It will be seen by the table that by far the most common and important reason for which operation was undertaken was dyspnœa. I have never declined to attempt the removal of any innocent goitre on account of the mere severity of the dyspnœa; in many of the cases there was a very high degree of dyspnœa; often it had existed for years and led to serious complications such as dilatation of the heart, tachycardia, and chronic lung complications. Many of the patients were quite unable to lie down, and had to be operated upon in the semi-recumbent position. In the great majority of cases the dyspnœa was not so extreme, although practically always enough to cause the patient considerable distress. In this series there has been no such theatrical case as that of the girl, age 14, upon whom in 1901 I had to do a hurried bilateral extirpation as she lay in bed, quite unconscious from impending suffocation, which had supervened suddenly in the middle of the night.* On the other hand, I have to record an unfortunate case which is not in this series, although it ought to have been, and I wish it had been. It was that of a man, age 20, admitted to the Royal Free Hospital, Feb. 3, 1914, with a large soft parenchymatous goitre of five years' duration, which for eighteen months or more had caused gradually increasing dyspnœa. It was thought that he would improve and be in a better condition for operation after a day or two of rest in bed, as such cases usually are. He passed a fairly comfortable night, but in the early morning sudden suffocation occurred, and he was dead before even the house surgeon could reach him. In this case it was an error of judgement on my part not to have operated directly I saw the patient, in which case I should doubtless have saved his life. The goitre, which is seen from behind in *Fig.* 287, was symmetrically bilateral and purely parenchymatous, the lateral lobes just meeting behind the pharynx and œsophagus. The trachea was compressed

FIG. 287.—View from behind of a large parenchymatous goitre with larynx and trachea, showing the usual scabbard shape of compressed trachea. From a man with chronic dyspnœa, age 20, who died of suffocation suddenly in his bed, before any operation had been attempted.

* *Case* 136, *Lancet*, 1902, i, 1227, and *Proc. Roy. Soc. Med.*, 1907, Nov. 12, 39. This patient has recently been seen by me and is in excellent health.

laterally in the usual manner for nearly 2 in., the lumen being a mere chink. The goitre, after removal from the body together with the larynx and trachea, weighed 26¾ oz.

In no case during this period of seven years have I performed a tracheotomy for innocent goitre, holding as I do very strongly that removal of the source of pressure, namely the goitre, is a far more satisfactory proceeding than mere tracheotomy. There are, of course, cases in which the operator, owing to circumstances which preclude the possibility of doing a clean thyroidectomy, may be compelled to attempt a tracheotomy under conditions of extreme urgency.

Tracheotomy for suffocating goitre is apt to be a difficult proceeding, and far more dangerous to life, owing to septic complications, than a clean thyroidectomy performed under proper conditions. The trachea is often deeply buried under the mass of goitre; it may be much displaced and difficult to find; the constricted region of the trachea may be, and often is, behind the sternum. The dyspnœa of goitre being due, not to spasm of the larynx, but to direct pressure upon the trachea, is not relieved by merely opening the larynx or the upper part of the trachea. It is generally quite impossible to reach the trachea below the constriction, and if the trachea be opened above it, an unusually long tube (such as Koenig's), which is not always at hand, must be employed. Our museums and surgical literature abound in illustrations of futile attempts to perform tracheotomy under such conditions. When it has been successfully performed, the mortality is considerable, and the patient still has the goitre pressing upon his trachea.

In cases of high degree of dyspnœa the operator will nevertheless do well to have tracheotomy dilators and a long tube at hand in case he may have to use them during the performance of the operation. There have been awkward moments during many of the more severe of my operations, especially during the dislocation of the tumour, when it has seemed that tracheotomy might become necessary. Even after the goitre has been removed, there is sometimes a danger of tracheal collapse. I have occasionally had to watch a flattened trachea for some little time after removal of the goitre before I ventured to close the wound over an unopened trachea. Fortunately many of the most severe cases of acute dyspnœa occur in young subjects with bilateral compression, in whom the trachea still retains much of its normal elasticity. In such cases the flattened trachea very quickly recovers from its compression. In older people recovery is much more slow, but the degree of compression is usually not so great.

An important point may here be insisted upon, which is, that in the case of bilateral compression of the trachea, the removal of one lobe alone may be quite insufficient to relieve the dyspnœa, indeed may even make it worse. The bilaterally-compressed scabbard-shaped trachea, so long as it remains in the middle line, may permit the passage of sufficient air to keep the patient alive. But remove one lobe, and the opposite lobe immediately pushes the trachea away from the middle line, bends it, and produces a kink which may easily lead to a fatal suffocation.

I would venture to lay down a rule that in cases of bilateral goitre with high degrees of dyspnœa, it is often dangerous to be content with a unilateral operation. After one lobe, or the major portion of it, has been removed, the operator should always examine the condition of the trachea and of the opposite lobe very carefully, and be prepared if necessary to remove also the lower portion of the latter. Much depends naturally upon the degree of stenosis, and the skill and judgement of the operator.

Another point with regard to dyspnœa which is sometimes overlooked, but which is of much practical importance, is this, that it is by no means the most prominent or the most obvious portion of the goitre that is the real cause of the dyspnœa. There are many cases in the present series in which an obvious, prominent, apparently unilateral goitre was considered by the patient, and sometimes even by his doctor, to be the cause of the severe dyspnœa from which he was suffering. Nevertheless in these cases it has often been the *opposite* lobe that has been the real offender, and which is the one that requires removal, lying deeply, perhaps even wholly unsuspected, behind the sternum or in the thorax. The key to the position in such cases is to be found in a careful examination of

the root of the neck, where the top of the offending mass can often be felt ; or in observation of the exact position of the trachea, displaced away from the source of pressure. In some cases an *x*-ray examination, if it can be obtained, may be most useful, showing as it may do, not only the deeper portion of the goitre, but the position of the trachea, which shows up as a band of light in the skiagram. An inexperienced operator may easily remove the wrong half of the goitre.

FIG. 288.—No. 1338. Skiagram of a comparatively small left-sided, almost wholly intrathoracic goitre, showing the trachea, which appears as a band of light, displaced to the (patient's) right. In the neck a right-sided goitre bends trachea slightly to left in an S shape. M., age 54. (*See also* FIGS. 289 and 290). Skiagram was taken the day before removal of the intrathoracic portion, which weighed 6 oz.

If a parenchymatous goitre in a young subject—that is, a goitre uniformly enlarged in all parts—presents one lobe which is much more prominent than the other, it is nearly always the *least* prominent, that is the deeper, lobe that most urgently demands removal. Similarly in older subjects, if a large rounded prominent mass fairly high up in the neck is accompanied by serious dyspnœa, it will often be found that the true cause of the dyspnœa lies in an enlargement of one or other inferior horn which lies jammed in the upper opening of the thorax. A typical example, from among many, may be cited.

A retired merchant, age 70, was sent to me in 1918 with a history that for several years he had had some difficulty in breathing, together with tachycardia. Both symptoms had become much worse in the last few months. Recently he had been treated for 'heart disease' in a nursing home for twelve weeks without much benefit. A *right*-sided goitre as large as a hen's egg, fairly high up in the neck, was then supposed to be the cause of his trouble, and it had been suggested that the removal of this would benefit him. When, shortly afterwards, he came to me, it was obvious that the real cause of all his trouble was an old *left*-sided goitre jammed in the upper opening of the thorax. The top of this could easily be felt when the head was extended and the goitre thus drawn up. His heart, examined for me by Dr. Strickland Goodall, showed the usual dilatation so often seen with chronic goitre, extreme irregularity, and auricular fibrillation. After

FIG. 289, *a* and *b*.—No. 1338. Bilateral goitre, right side cervical, left side almost wholly intrathoracic. M., age 54, who had suffered for some years from increasing paroxysmal dyspnœa. (*a*) Condition when at rest. (*b*) Condition when straining, the top of the intrathoracic portion then rising into the root of the neck.

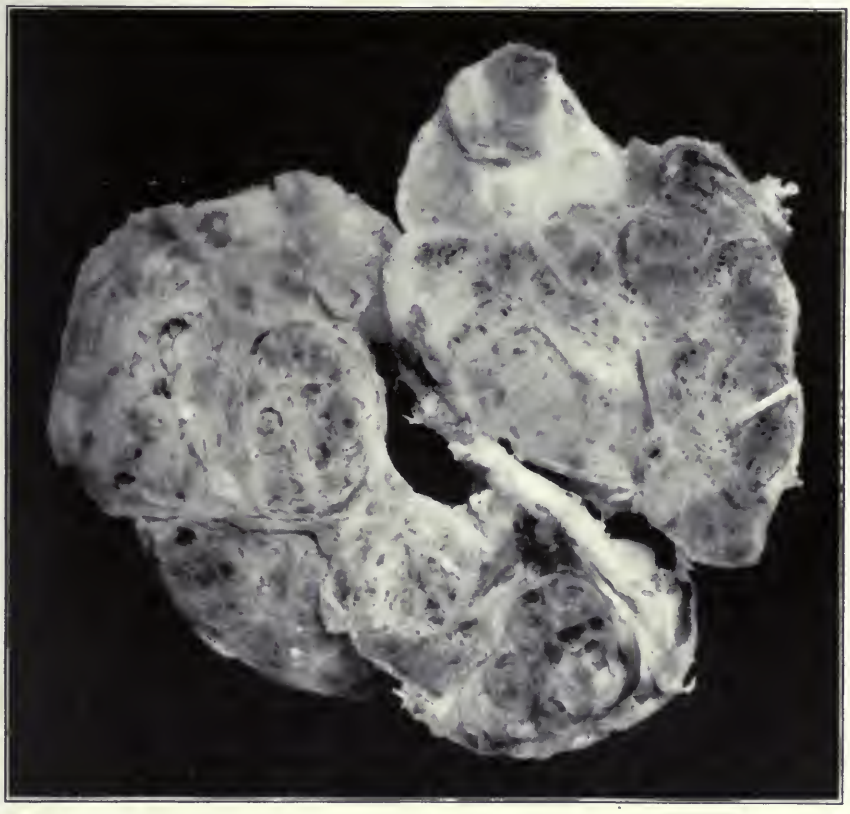

FIG. 290.—No. 1338. Left-sided intrathoracic tumour removed by extirpation from the preceding. Adenoparenchymatous, with some calcification of lower horn. Weight of intrathoracic portion 5½ oz.

giving him a few days' rest in bed in a nursing home and some treatment with digitalis, I removed the left-sided intrathoracic goitre, about as large as an orange. It had evidently been there for many years, as it was largely fibrotic. The recent enlargement was due to the accumulation of some fluid within it. The patient made a rapid recovery, and was able to leave the home a fortnight after the operation, with his wound soundly healed. His heart gradually recovered its tone, and he is now in good health with a regular quiet pulse. He is able to rush about the country and make long political speeches without effort.

Discomfort, Deformity, and Slight Dyspnœa.—In this group, which comprises one-fifth of all the cases, are included those in which the goitre, mostly unilateral, was removed partly on the ground of discomfort produced by pressure, and partly because of the deformity, often very considerable. Really severe dyspnœa was not present in these cases, although in many of them the steady growth made it probable that serious dyspnœa would occur later if no operation were undertaken. In most of them slight dyspnœa occurred on exertion, and many had other symptoms such as tachycardia, palpitation, dysphagia, and various nervous symptoms. It was noticeable that many of these patients, who before the operation had not complained of dyspnœa, volunteered afterwards the remark that they could breathe much better than before. A large number also stated that, besides enjoying freedom from local symptoms, their general health had improved very much. Those who were below the normal weight before the operation—and most patients with such goitres are thin—usually regained it afterwards. In this group comes the patient from whom the largest goitre in the whole series was removed. He was a young man, age 21, who had had for several years a gradually enlarging parenchymatous goitre which caused him much discomfort, mainly from its bulk and weight. Nearly the whole of the right lobe, together with four-fifths of the left, were removed without difficulty. The total weight of the parts removed was 3 lb. 0¾ oz. (R. 27½ oz., L. 21¼ oz.). He made a rapid and excellent recovery, and was subsequently for three years on active service in the army, which he has only recently quitted. *Fig.* 291 shows his condition some three or four years after the operation.

FIG. 291.—No. 1019. Patient, age 24, about 3 years after bilateral extirpation for discomfort, bulk, and weight, of a parenchymatous goitre weighing 3 lb. and ¾ oz. (The largest of this series.)

Deformity.— In 17 cases only was the operation done mainly for deformity (hospital cases 5, private 12). Two patients were men, the rest women. All except four were under 40 years ; of these, one was a man, age 50, with a very unsightly lump as big as a golf-ball, situated directly in front of the larynx ; the other a man, age 73, with a very large mass which weighed 22 oz. after removal. All the tumours were unilateral, and most were of various sizes from that of a walnut to that of a goose's egg. In all cases the wounds healed by primary union, and the patients were all quite well when last seen or heard of, one only three months, the rest from two to seven years, after the operation. Operation is never performed for mere deformity for small or moderate-sized parenchymatous goitres. Such cases are best treated by medical means, which should include a search for, and if possible removal of, the primary source of trouble.

True Exophthalmic Goitre.—The reason for operation in all these cases was the existence of well-marked clinical symptoms of Graves' disease, and not the presence of the local trouble. Marked dyspnœa was not present in any case, and even slight dyspnœa was wholly absent from most. It is not necessary to dwell further upon the well-known

symptoms of the disease, to which, moreover, allusion has already been made in the preceding section.

Malignant and Papilliferous.—In this class have been placed together, for convenience, all cases which were proved to be of this nature, although the principal reason for the operation was not necessarily a definite diagnosis of malignancy. In one case of a large solid adenocarcinomatous tumour, for instance, dyspnœa was the primary cause of the operation ; in another it was pain ; in the third it was the presence of spontaneous suppuration that demanded operation. Out of a large number of cases of malignant disease seen during the period, only twelve cases were submitted to operation. One case of papilliferous carcinoma underwent two operations.

Suspected Malignancy.—The 5 cases of this group were all elderly people (3 women, 2 men), whose ages were from 46 to 61. All had comparatively small tumours, with a history, sometimes afterwards proved to be erroneous, of short duration. None were definitely diagnosed as malignant; indeed in none was it thought that malignancy was very likely to exist. But in each case there was some point which made it very difficult to say that the case was not one of an early stage of malignancy, and it seemed better to subject the patient to the trivial risk of a small and easy operation rather than to leave the tumour, especially as all the patients were alarmed and anxious for operation. In one case it was paralysis of the sympathetic nerve and slight dysphagia, in another unusual hardness and irregularity, in another a small hard lump at the back and inner part of the gland causing discomfort and pain, in the other two hardness with very short history, that led to the operation. All made excellent recoveries and are known to be quite well at the present time.

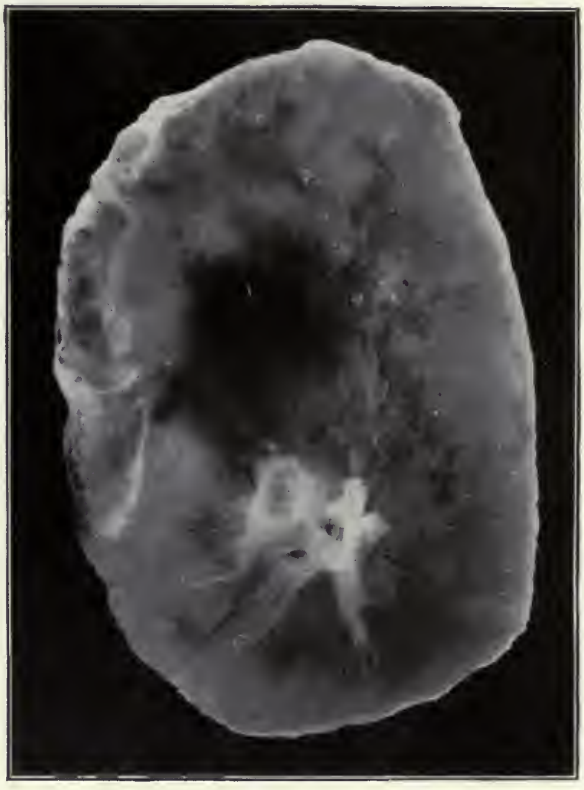

FIG. 292.—No. 1275. Solid adenoma showing the common star-shaped central fibrous mass, with commencing calcification. Weight 9¼ oz. F., age 43. Removed on account of discomfort and slight dyspnœa. (*R. Free Hosp. Mus.—Ea. Cg.* 9030.)

During the same period many cases have been sent to me with a diagnosis or a suspicion of malignancy in which I was able to state definitely from the physical characters of the tumours, and the history, that the disease was non-malignant and that no operation was necessary. In none of these cases, so far as I am aware, did malignancy subsequently develop.

There is another important class of case, however, that deserves special mention. It is not uncommon for an elderly patient with a large, often bilateral, hard, and somewhat fixed goitre to give an indefinite history of the occurrence recently of symptoms such as slight pain, slight enlargement, or some vague feeling of discomfort which raises a suspicion, but merely a suspicion, of the supervention of malignancy. In such cases, in the absence of any of the more definite signs of malignancy, such as recurrent laryngeal

paralysis, marked dysphagia, adhesion to neighbouring structures, etc., it may be impossible to say more than that the disease may possibly be malignant. In such cases of elderly patients whose general health is quite good and who are not suffering from any local trouble due to the goitre, it is generally unwise in my opinion to subject them to what must necessarily be an extensive and severe operation which will probably prove to have been quite unnecessary. Frequently the symptoms are due to the development of a small cyst or a little hæmorrhage in the depths of the tumour, for which it is quite unnecessary to do any large operation.

In a certain number of such cases there may really be malignant disease, and, if it could be diagnosed with certainty, even a large and dangerous operation would be quite justifiable. The treatment must depend upon the judgement and experience of the individual surgeon, the severity of the proposed operation, and the probability of the patient being really benefited by it. For it must not be forgotten that sometimes very extensive malignancy exists without any pain or any of the other ordinary clinical manifestations. The disease may be found to be wholly inoperable owing to infiltration of the deeper structures, while the patient's general health is still perfectly good. To operate on such a case often means putting the patient at once into a condition of grave discomfort and danger from which he will probably never recover. If not operated upon, he may enjoy many months or even a year or two of comparative health and comfort.

FIG. 293.—No. 1256. Left lobe bilateral adenoparenchymatous goitre showing extensive central calcification. F., age 47. Partial bilateral extirpation for increasing bulk and discomfort. Weight 12½ oz.
(*R. Free Hosp. Mus.—Ea. Cg.* 9035.)

A very important point to consider before undertaking an operation for the removal of a supposed undoubted malignant goitre is whether the gland moves, not only on swallowing, but *also upon the larynx and trachea.* Many a malignant goitre which moves quite freely up and down with the larynx and trachea will be found at the operation to be so hopelessly incorporated with the trachea, and possibly also with the œsophagus, as to render satisfactory removal out of the question and the operation perfectly futile. On many occasions I have known want of attention to this point to have induced young surgeons (including myself, in the past) to embark upon useless and unjustifiable operations which had much better not have been attempted.

Out of many cases that illustrate the above points I will cite briefly two :—

Case 1.—In March, 1919, a lady, age 72, who had had a goitre for at least twenty-five years, was brought to me because she thought that in the last three months it had grown a little larger, and had caused a little discomfort. There was no loss of flesh, no dysphagia, dysphonia,

or dyspnœa, nor any other certain sign or symptom of malignant disease. The thyroid presented itself as a very hard bilateral mass low down in the neck, each lobe being as large as a hen's egg. The mass moved freely with the larynx and trachea, but could not be moved freely upon the trachea. I told the doctor that there was a very strong suspicion of malignancy in this case, although I could not be absolutely certain, as there was no definite evidence of the tumour having altered in size or consistency for many years, and that it was *possible* that it might be merely an old calcified or fibrotic goitre of long standing. What was quite certain, however, was that "whatever it is, no operation is desirable: if it is malignant, operation is out of the question on account of the extent of the disease; if it is non-malignant, no operation at all is necessary". Two months later the tumour was a little larger, but the feeling of discomfort had almost gone. The diagnosis of carcinoma was now fairly certain. From time to time I heard of her, that she was able to get about and enjoy life, but that the tumour was slowly growing, although causing no fresh symptoms.

In October, 1920, nineteen months after I first saw her, she was brought to me again. She was still able to get about, and was not suffering to any great extent. The tumour had now grown to the size of a man's fist. It was irregularly hard and knobby; the carotid artery was not palpable. There was still no dysphagia or dyspnœa, but there was a little irritative cough. The general condition was still good, but the patient was pale, and it was evident that she was beginning to fail. I heard from her doctor recently that a few weeks later she got very rapidly worse, and that she died just a week ago, 21 months after I first saw her, without having had any serious suffering or discomfort until within the last few weeks. The post-mortem showed an extensive carcinoma.

On the other hand, a year later, in March 1920, an almost exactly similar case was brought to me by another doctor.

Case 2.—This patient was a lady, age 59, who had had a bilateral goitre for many years—at least seven—and, according to her husband, probably about twenty years. For about three months she had complained of some laryngitis and cough, but she had no pain, dysphagia, or dyspnœa. Both lobes of the thyroid were enlarged, on one side to that of a hen's egg, on the other to twice that size; as in the previous case, the tumour was low down in the neck; it moved freely with the trachea, *but not upon it*. The carotid artery could easily be felt on one side but not on the other. This was the most definite point in favour of malignancy. As before, the diagnosis lay between old adenoparenchymatous goitre and malignancy supervening upon an old innocent goitre, although in this case I was inclined to take a somewhat more hopeful view of the case, in spite of the condition of the carotid artery. My notes record that "if the tumour is malignant, curative operation is out of the question; if innocent, the symptoms are not bad enough to demand operation". It was arranged that she should see me again in three months' time, or sooner if necessary. Before the expiration of that time, however, I heard that she was dead. On making inquiries, I learnt that, upon the advice of a friend, she had subsequently consulted another surgeon who had been bold enough to advise and to attempt removal, which was performed six weeks after I saw her. The doctor has kindly given me a full account of the operation, which presented great difficulties. "Owing to the isthmus being very adherent, in raising this, the trachea got torn . . . . a fœtid bronchitis supervened", and the patient died of this six weeks later. The removal was stated to have been "probably incomplete". It is only fair to add that I am informed that in the interval which elapsed after I saw the patient dyspnœa seems to have developed, and some such operation as tracheotomy may have been desirable. But on the other hand the condition, which was hopelessly inoperable as regards any prospect of cure when I saw the patient, is not likely to have been any more favourable six weeks later. The case is one which young and confident operators will do well to remember.

Primary Chronic Inflammation.—The case showing this condition has already been fully described in *Section III.*

Palpitation, Nervousness, etc.—The 12 cases included in this class are instances of what, for want of a better term, I am in the habit of calling 'false' exophthalmic goitre. They are very common. Many others presenting similar symptoms might also have been placed here, but have been put under dyspnœa, or elsewhere, since this was the main reason for the operation. These cases, although often classed as 'exophthalmic goitre', ought, in my opinion, not to be so called. They do not develop exophthalmos, although they may present nearly all the other symptoms of that disease; the gland after removal does not present the appearances characteristic of that disease. What is still more important, operations upon them do not carry with them the same risk, or anything approaching the risk, of the operation for true Graves' disease.

I am not speaking of the so-called Basedowified goitre, cases in which to an old simple goitre have been added all the signs and symptoms of true Graves' disease. Such cases,

in my experience not very common, are really cases of true Graves' disease, and are accompanied not only by exophthalmos, but by the characteristic pathological appearances of that disease, which are seen in the gland side by side with the evidence of the old pre-existing goitre, whatever its nature.

The cases in the class which I am now describing are ordinary goitres, generally unilateral, often simple adenomata or cysts, sometimes parenchymatous, but which do not present exophthalmos or the pathological appearances of Graves' disease. The term 'thyrotoxic' adenoma is often applied to them, but I am not at all sure that the theory which this name implies is a correct one, although it may be. What is important clinically is that the removal of the tumour, which is generally a simple operation, and practically as safe as that for ordinary goitre, will usually result in the patient quickly losing all her unpleasant symptoms and being completely restored to health, which is by no means always the case after operations for true exophthalmic goitre.

There are, of course, exceptional cases which are difficult to classify, especially in the early stages, but on the whole the three groups that I have mentioned are fairly well defined and easily separable from each other.

The following may be cited as a typical example of the class of 'false' Graves' disease :—

No. 957.—Mrs. H., age 35, had had for ten years a right-sided goitre, and for five years had been subject to palpitation. She had had no serious dyspnœa, but had lost weight considerably of late. There was no exophthalmos, and she had not had diarrhœa. The heart was slightly dilated and the pulse quick and irregular.

In July, 1914, the tumour was removed by resection-enucleation without any difficulty. It was an ordinary encapsuled adenoma as large as a hen's egg, and weighed 2¼ oz., five-sixths solid, the rest consisting of clear fluid. The pathological examination showed no signs of true Graves' disease. The wound healed by first intention, and the patient went home on the nineteenth day after the operation. When seen again two months later she both looked and felt much better. She had gained weight and lost her palpitation, although she still had some tachycardia and slight cardiac irregularity; she stated that her heart gave her less trouble than before. In September, 1920 (six years later), her husband writes me from the country that "the operation was a complete success, as she has not had signs of any trouble since ".

V. NATURE OF OPERATION.

Table V.

Extirpation	190	
Resection-extirpation	119	
Extirpation and enucleation	4	
Extirpation and resection-enucleation	1	
	—	314
Enucleation	13	
Resection-enucleation	168	
Resection-enucleation and enucleation	5	
	—	186
Total		500

Operations performed :—Right side	252	
,, ,, Left side	135	
,, ,, Bilateral	83	
,, ,, Right side and isthmus	21	
,, ,, Left side and isthmus	8	
,, ,, Not known	1	
Total	500	

Of the figures in this table it is not necessary to say much. It will be seen that the extracapsular operations of extirpation and its varieties greatly exceed the intracapsular operation of enucleation and its varieties. Among the latter it will be noticed that pure enucleation is now but rarely performed, having been almost wholly superseded by the much better operation of resection-enucleation, in which the thinned and degenerated

layer of glandular capsule is removed together with the tumour (*Fig.* 295). This leaves behind a much smaller surface of wounded gland.

One sometimes hears surgeons speak of the ' shelling out of a *lobe* ', in my opinion a most dangerous proceeding. The principal danger of the shelling out (enucleation) of even an encapsuled tumour, to which alone this operation is applicable, is that of penetrating the posterior, and often very thin, layer of investing glandular capsule, and causing serious venous hæmorrhage or damage to the recurrent laryngeal nerve. If the shelling out of a whole lobe—that is, an extracapsular operation—were attempted, it would be scarcely possible to avoid most serious venous hæmorrhage. Pure enucleation is now reserved almost entirely for cases of quite small and superficial encapsuled tumours enclosed in a relatively thick layer of fairly healthy thyroid-gland tissue. If this table be compared with the similar table in which I gave, in 1913,* the statistics of my previous series of operations (Nos. 401–751), it will be seen that in the earlier series the enucleation class of operation comprised four-sevenths of the total number, while in the present series it comprises only a little over one-third. In other words, intraglandular operations are being replaced more and more by extracapsular ones, but these are never ' shelling-out ' operations.

FIG. 294.—No. 223. A well-encapsuled solid adenoma (fœtal type) covered by thick layer of compressed but otherwise fairly normal gland-tissue. F., age 36. Removed by resection-enucleation.

FIG. 295.—Encapsuled solid adenoma after removal by resection-enucleation. Surface of tumour proper is seen on the right, that of thin investing layer of thyroid gland on left.

Total extirpation of even one whole lobe is, however, now but rarely performed by me, except for malignant disease, and in a few other exceptional cases.

A portion of gland, usually about as large as a normal lobe, is practically always left at the hilus, or ' dangerous area ' as it has been called. I consider this to be a great improvement on earlier practice. Total removal of the whole thyroid gland I have never performed in the whole of my practice. I consider it to be an entirely unjustifiable proceeding, never necessary even for malignant disease, and still less for exophthalmic goitre.

The combined operation (e.g., extirpation and enucleation) refers of course to the different treatment of the opposite sides of the gland at the same operation.

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* Lettsomian Lectures. *Trans. Med. Soc. Lond*,, vol. xxxvi.

VI. INTRATHORACIC GOITRE.

Table VI.

Patients	22
Operations	22
Males (average age 51 years)	8
Females (,, ,, 46 ,,)	14
Unilateral operations	17
Bilateral ,,	5
Parenchymatous	6
Adenoparenchymatous	11
Solid adenoma	4
Cystic ,,	1
Weight in oz. or size (male)	Orange, orange, 12, 9¾, orange, orange, 8, 4
,, ,, ,, (female)	?, ?, 11½, 8, 3¾, ?, 7½, 28, 6¾, 5, 7, 6¼, 12, 12
Primary union	17
Sinus—few days to few weeks	5
Complete recovery	22

As a general rule it may be stated that the lower down in the neck a goitre is situated, the more likely it is to produce serious or dangerous dyspnœa. Many goitres, especially unilateral ones, are situated behind the inner end of the clavicle or upper border of the sternum, and becoming jammed between these parts and the projecting vertical column, displace and flatten the trachea obliquely, thus causing severe dyspnœa. To these the terms retroclavicular and retrosternal* goitre may be applied.

But in many cases the goitre descends still lower, below the level of the first ribs, thus lying partly or even wholly within the thorax proper. If enlargement and consequent tracheal pressure take place in this situation, the term *intrathoracic* is applicable.†

FIG. 296, *a* and *b*.—No. 893. (*a*) Solid unilateral, mainly intrathoracic, goitre, the upper part of which rises into neck. F., age 65. (*b*) Side view. Removed by resection-enucleation on account of dyspnœa and œdema of the arm. Note the distention of the veins of the neck.

The goitre may be wholly intrathoracic or only partly, the upper part forming an obvious swelling in the neck (*Fig.* 296). Any kind of goitre may be intrathoracic, but in the great majority of cases the goitre does not become intrathoracic, or at any rate is not diagnosed as such, until the patient has reached middle age. Adenomata, cysts, and

* The term retrosternal or substernal goitre is also applied by many authors to goitres situated still lower down, behind the manubrium or body of the sternum; for these I prefer the term intrathoracic.

† It is quite common for the tip of one or both inferior horns of a goitre to descend for a short distance into the thorax, but without causing pressure in this region—such cases are, of course, not included among the intrathoracic goitres.

other more or less encapsuled masses in connection with old adenoparenchymatous goitres are therefore much more common than the purely parenchymatous form. Occurring thus in elderly people, most intrathoracic goitres have undergone a good deal of secondary degeneration, fibrosis, calcification, etc., which is in one respect a fortunate

FIG. 297, *a* and *b*.—No. 893. The same patient as in *Fig.* 296, three months after operation.

circumstance, as it enables the exact shape and position to be more clearly shown by radiography. In only 2 of the 22 patients of this series was the age below 30, while the average age, as will be seen from the table, was much higher. Two patients were over

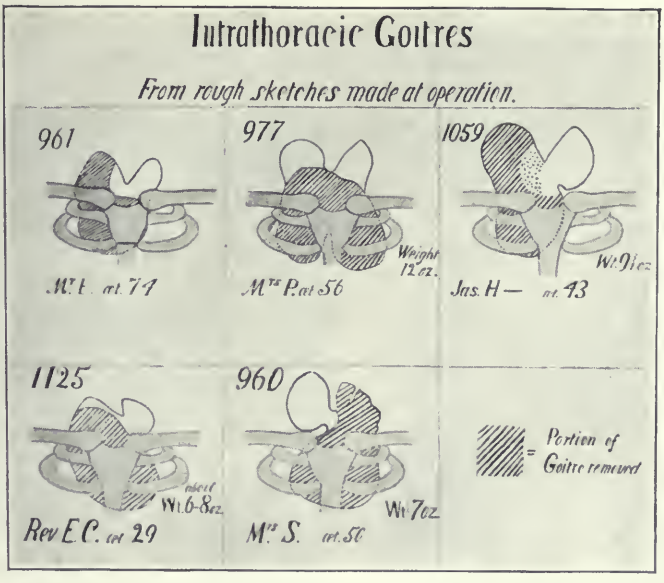

FIG. 298.—Intrathoracic tumours of various kinds. From rough semidiagrammatic sketches made by author immediately after the operations.

70. The large proportion of men (8 out of 22) is noticeable, as is also the fact that no less than 17 out of 22 occurred in private practice. The last point is difficult to explain, unless it be that many of these patients came from distant parts of England (or even from abroad) for operation, and that hospital patients are perhaps more likely to be treated in hospitals nearer their own homes.

Intrathoracic goitres are usually attended with very severe symptoms, both respiratory and cardiac, but especially the former. But if situated entirely within the

thorax and well below the first ribs, they will sometimes produce very few symptoms until they suddenly or gradually enlarge and produce severe pressure symptoms.

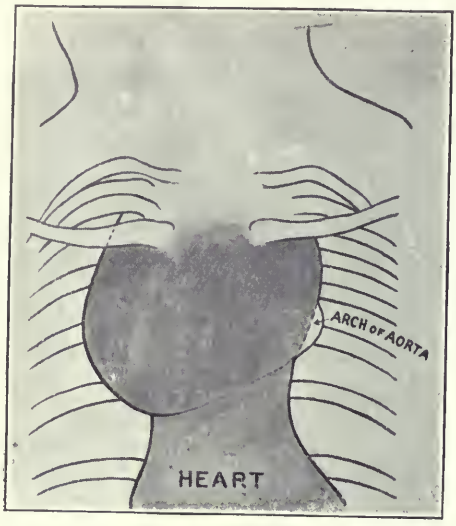

FIG. 299.—No. 779. Semidiagrammatic representation of a double but mainly right-sided, solid, intrathoracic goitre, removed in 1913 by extirpation from a lady, age 64, for dyspnœa. Weight 11½ oz. Taken two days before operation.

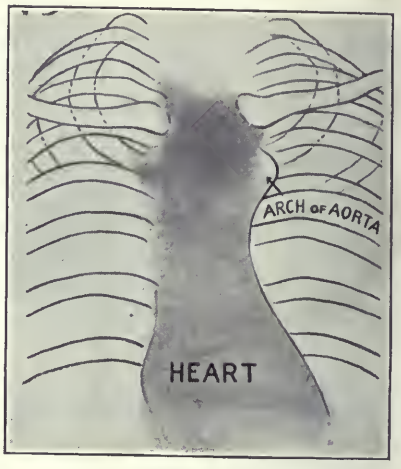

FIG. 300.—No. 779. Semidiagrammatic representation of the preceding three months later, from a tracing of the skiagram, omitting irrelevant details.

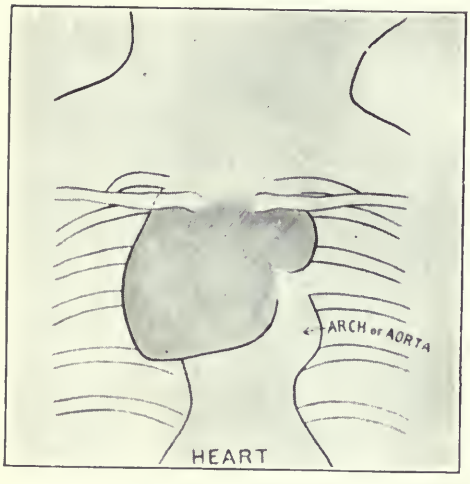

FIG. 301.—No. 1329. Semidiagrammatic representation of a bilateral, mainly right-sided, wholly intrathoracic goitre, removed by extirpation for severe paroxysmal dyspnœa. Taken shortly before operation.

FIG. 302.—The same patient a fortnight later, showing scar of low transverse incision through which tumour was removed.

A very common history is that the patient has had a goitre for years, and that as the goitre became apparently smaller (i.e., became sucked down into the thorax) the dyspnœa (often diagnosed as 'asthma') became worse. It is not uncommon for one side of a bilateral goitre to form an obvious tumour in the neck, while, on the opposite side, lying wholly unsuspected in the thorax, is an intrathoracic goitre which is the real cause of the dyspnœa. A case of this kind has already been cited in *Section IV*.

Intrathoracic goitres, unless parenchymatous in young people (which are very unusual), are but rarely amenable to any kind of treatment short of direct removal by operation. Fortunately, in the great majority of cases these goitres can be removed by a well-executed, although naturally a somewhat serious and difficult, operation. The patients, who have usually suffered extremely from dyspnœa, and whose lives have probably been in great danger from it, are usually only too willing to submit to an operation which offers them a good prospect of complete cure. These operations are among the most satisfactory goitre operations that I have to do.*

The operation depends for its feasibility and success upon attention to the following points: (1) As the goitre grows downwards into the thorax it carries its main vessels with it; consequently none enter it from below upwards. If this were not so, the operation would be impossible. (2) Most of the main veins lie in front of the goitre, and no attempt should be made to extract it until these have been carefully clamped or tied. Frequently it is desirable to free the upper part of the lobe, if this is in the neck, by isolating and tying vessels in the usual manner. When these vessels have all been secured, and the top of the tumour itself has been freely bared, but not till then, the extraction may be attempted. No attempt should be made to pass any instrument down into the chest *in front* of the tumour. But at the back a space will always be found through which it is possible to pass a scoop, or better still an ordinary silver dessertspoon or tablespoon, into the chest, behind and below the goitre. The spoon must have a rounded, not a pointed, lower edge, lest it should leave the surface of the goitre and perforate some adjacent structure such as the pleura, an accident which, however, I have never actually seen. The rounded bowl of the spoon pushes the pleura away from the goitre and facilitates its separation. *Fig.* 303 shows the pattern of spoon that

Fig. 303.—The form of silver spoon used by the author. (*Full size.*)

* In the present series there were no deaths. In the preceding series (published 1913, loc. cit.) there was 1 death among 18 cases. The patient, the skiagram of whose thorax before and after operation was published in 1913 (*Trans. Med. Soc.* xxxvi, 197), still enjoys robust health at the age of 70, eight years after the operation.

I commonly employ.* The position of the recurrent laryngeal nerve must be borne in mind. The spoon must be inserted between this and the goitre. Damage to the nerve is one of the main dangers of the operation, and I have not always been able to avoid it (*see No.* 779, *Fig.* 299).

If the goitre is old and tough, and has a well-marked capsule, several pairs of forceps may be placed upon the front of it and traction made together with a scooping movement of the spoon. If the tumour is partly cystic, so much the better, as the size may be considerably diminished by letting out some or all of the fluid.

If solid and too large to be extracted whole through the upper opening of the thorax, I have sometimes broken up the interior to reduce the size; but this is a somewhat dangerous proceeding, and, if attempted, care must be taken to keep away from the periphery of the tumour where most of the veins lie.

If the goitre is unequally bilateral, the smaller part should always be removed first, to relieve the breathing and to give more room for the extraction of the larger tumour.

The most dangerous moment of the operation is when the tumour is being delivered through the narrow upper opening of the thorax, since it is just at this time that most pressure is exerted upon the already narrowed trachea. As soon as the goitre has been delivered, a long piece of gauze is lightly packed into the thorax so as to fill up the cavity and check any oozing from its walls and to minimize the risk of infiltration of blood into the surrounding tissues.

Patients with intrathoracic goitre often have attacks of paroxysmal suffocative dyspnœa alternating with periods of comparative freedom from dyspnœa. If the patient has an ordinary cold the symptoms are likely to be worse, probably from temporary swelling due to increase of fluid in the tumour. If possible, a period of intermission, when the breathing is least troubled, should be chosen for operative interference.

VII. ANÆSTHESIA.

Table VII.

Year	Operations for Removal	General	Local	General and Local
1913	119	106	12 (11 of these were for exophth. goitre)	1 (1 of these was for exophth. goitre)
1914	136	116	11 (3 „ „ „ „)	9 (8 „ „ „ „)
1915	—	—	—	—
1916	59	59	—	—
1917	—	—	—	—
1918	75	73	2 (1 „ „ „ „)	—
1919	111	108	2 (1 „ „ „ „)	1 (1 „ „ „ „)
Totals	500	462	27 (16 „ „ „ „)	11 (10 „ „ „ „)

Mere ligations of thyroid arteries for exophthalmic goitre have not been included in this paper; for many of these operations local anæsthesia was employed. There were no deaths in connection with any of these operations.

No anæsthetic fatality occurred in any case, either of removal or of ligation.

Having quite recently discussed at some length† the subject of anæsthesia for goitre operations, it is unnecessary here to do more than recapitulate briefly my present views on this subject. Chloroform is never employed now in any of my goitre operations. For

* The use of a spoon I learnt, many years ago, from my friend Dr. Charles Mayo.

† Discussion on "Anæsthesia in Operations on the Thyroid Gland", opened by Dr. May Dickinson Berry, *Proc. Roy. Soc. Med.*, 1920, xiii (Section of Anæsthetics).

general anæsthesia ether is administered by the open drop method on a mask of gauze. Deep anæsthesia is never permitted at any stage of the operation, as in many cases it would be highly dangerous, especially in the earlier stages. The patient should be just sufficiently under the influence of the anæsthetic to avoid pain. In a few cases of a high degree of dyspnœa, local anæsthesia is preferable, especially if the services of an anæsthetist of large experience in this class of operation is not available. In a good many cases of exophthalmic goitre also, local anæsthesia is preferable. But in both these classes of case I am using light general anæsthesia more and more, in preference to local, which is often very distressing to the patient. In some cases local anæsthesia is used at the beginning, and light general anæsthesia in the later stages, of the operation.

Of intratracheal anæsthesia, which is much praised by some, I have no personal experience. It can doubtless be employed with safety in a large number of ordinary goitre operations. But in just those cases in which it would at first sight seem to be useful, I hesitate to employ it, on account of its danger. I have heard of several cases where death occurred during or shortly after its employment for goitre operations, or in which death has occurred during the attempt to employ the method. The necessity of anæsthetizing the patient in the ordinary way before the intratracheal tube can be introduced, the necessary hyperextension of the head, and the occasional failure to get the tube past the point of obstruction in the trachea, are all serious objections which have been well pointed out by Crotti in his recent excellent book on thyroid surgery.* To these I would add that, in the case of a trachea already partly narrowed, the addition of even a very little inflammatory swelling set up by the mechanical irritation of the tube, however soft, might readily increase the post-operation risks. Crotti, an operator of large experience in goitre surgery, remarks that the method of "intratracheal insufflation anæsthesia in thyroid surgery seemed at first to be full of promise. I have, however, found it disappointing. Just in the cases where it was expected to be the most useful, namely in goitres with pressure symptoms, it failed to fulfil its expectations". He mentions no less than three cases in his own practice in which, when sudden unexpected dyspnœa occurred, he failed to introduce the tube into the trachea. In ordinary cases without much tracheal stenosis, it seems to me to possess no great advantage over simpler methods; and certainly patients sometimes complain much of laryngeal discomfort after its employment, although possibly this is less when the anæsthetist is highly skilled in the technical details of the method.

VIII. DRAINAGE.

This has been employed in all but 7 of the 500 cases; these seven were all small, short, and easy operations. After all large goitre operations, there is a good deal of blood-stained serous discharge, often mixed with colloid, especially in cases of parenchymatous goitre where a considerable surface of wounded gland has been exposed; it is better that this should pass out into the dressing rather than accumulate in the wound or pass into the surrounding tissues, and thus possibly hinder the smooth healing of the deeper parts of the wound. The drainage tube is always of glass and quite short, reaching to just below the plane of the infrahyoid muscles. A longer tube is apt to cause irritation and discomfort. The drainage tube is nearly always removed on the day following that of the operation.

The space beneath the large flap of skin and platysma is not drained, but in many of the more recent cases in the series half an inch at each end of a long skin incision has been left unsutured, to facilitate the escape of any fluid which might otherwise collect under this flap. The flexed position in which the head is kept for a day or two after the operation obviates the necessity for suture at these two points.

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* *Thyroid and Thymus*, 1918. Philadelphia and New York: Lea & Febiger.

IX. HEALING OF WOUNDS.

Table VIII.

Primary union	442
Primary union except in track of drain; healing in few days to few weeks	34
Apparent primary union; mild suppuration after leaving hospital or home*	6
Secondary union after gauze drain or pack	8
Persistent small sinus; healing 3 to 6 months	3
	493

* All healed except one malignant case.

It will be seen from the above table that in the great majority of cases the wounds healed smoothly per primam without any trouble at all. Of the 34 cases in which primary union occurred everywhere except in the track of the drain, some were cases in which some accumulation of blood-stained serum took place either in the deeper parts of the wound or, much more often, beneath the skin flap. In such cases the prompt insertion of a closed pair of forceps for an inch or two into the wound is sufficient to let out the fluid, and no further trouble ensues. Occasionally the track of the drain is mildly infected, presumably from the skin surface or from some fault in the technique; none of these cases were seriously infected.

The eight cases of secondary union were mostly those in which the occurrence of a subcutaneous hæmatoma necessitated partial reopening of the wound and superficial packing with gauze for a few days.

One (No. 776) was that of a girl from whom one lobe (as large as a goose's egg) of a parenchymatous goitre had been removed on account of dyspnœa: recurrent hæmorrhage occurred three hours after the operation: the whole wound was promptly opened up; a small bleeding vein was ligated and the wound lightly packed with gauze for a few days; the patient made a good recovery without any further trouble, and left the hospital on the twenty-first day after the operation.

Details of another case follow.

This was a very remarkable case, that of a lady, age 60, from whom I had, in 1896,* removed the right and most of the left lobe of a deeply seated, partly substernal, parenchymatous goitre, for dyspnœa. The parts removed weighed $11\frac{3}{4}$ oz. The operation was a very severe one, and was followed by mild suppuration and a sinus which did not heal for eight months, but she made a good although slow recovery, and remained quite well for many years. The remainder of the left lobe, however, had been gradually enlarging, and eventually caused such severe suffocative attacks that she came back to me for further operation. In July, 1914, eighteen years after the first operation, I removed a mass as large as her fist from behind the sternum and left clavicle. The operation, which was performed under local anæsthesia, was long and difficult owing to the existence of numerous old adhesions; the large cavity with unusually rigid walls had to be plugged with gauze, on account of deep-seated venous hæmorrhage from some vessel in the neighbourhood of the left innominate. She was apparently making a satisfactory recovery, when quite suddenly, twenty-eight hours after the operation, she became completely unconscious, with stertorous breathing and paralysis of all her limbs. It was thought at first that she was dying of cerebral hæmorrhage or an extensive sudden thrombosis. Her pupils were not contracted, and there was no evidence that she had taken any drug. Dr. J. A. Ormerod, of the National Hospital for the Paralyzed, saw her with me, and was unable to arrive at any definite diagnosis, but thought, as I and others did, that she was not likely to recover. However, after remaining unconscious for three days, she began to recover rapidly, and in less than a month lost all traces of her paralysis. The wound remained clean and healed very slowly by granulation in the course of about four or five months. She made an excellent and complete recovery, and for the last five years, during which I have frequently seen her, she has been in excellent health, full of energy, and leading an active busy life, in spite of her age. I am quite unable to give any explanation of the nature of this curious complication. The rapid and complete disappearance of all trace of paralysis makes it scarcely possible that there can have been a cerebral hæmorrhage, as was at first thought probable. I have never seen anything like it after any thyroid operation, and it is the only serious non-fatal complication that has occurred after any operation of this series.

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* *Case* 41 published and figured (*Figs.* 119 and 120) in my book on *Diseases of the Thyroid Gland* (1901), at present out of print.

X. DEATHS FROM OPERATION.

Table IX gives brief notes of all the cases that have died as the result, either direct or indirect, of the operation.

Simple Goitre.—No. 757 was a schoolmistress sent to me in 1913 by Dr. W. J. Durant, of Gateshead. In March, 1898, I had removed from her left thyroid lobe an encapsuled adenoma as large as a duck's egg on account of dyspnœa (No. 54). In the intervening fourteen years she had remained perfectly well, but the remaining lobe had recently been enlarging considerably, and an entirely new train of symptoms had supervened within the last year—namely, nervousness, tremor, palpitation, rapidity of pulse, which was persistently at or above 120, and, most important of all, emaciation and glycosuria. She complained of much discomfort and some dyspnœa, and was very anxious for further operation. It was thought to be a case of secondary Graves' disease. On account of the glycosuria, for which Dr. (now Sir) Archibald Garrod kindly saw her with me, she was kept in the nursing home for more than a fortnight, and I then did a resection-extirpation of most of the right lobe, which contained a well-encapsuled adenoma of the common colloid type with commencing cystic degeneration, and weighing 4½ oz. Microscopically the gland showed none of the changes of Graves' disease. After the operation, she soon developed a low form of pneumonia, and of this she died on the twenty-fourth day after the operation. The post-mortem, which was performed by Dr. C. S. de Segundo, who had been attending the patient with me for the pneumonia, showed solidification of one lung, but the mediastinum and root of the neck were quite free from any sign of sepsis, and the wound had healed. The sputum had been examined on two occasions with the following result. "*Films*: A small Gram-negative bacillus, resembling Pfeiffer's bacillus, is present in very large numbers; tubercle bacilli not found. *Culture* (blood agar plates): Influenza bacillus in great majority; pneumococcus also present, with a few colonies of a staphylococcus."

The case appears to have been one of an infection of an old adenoma simulating Graves' disease, as such cases sometimes do, and it would have been much better had I declined to operate upon her. But at that time my personal experience of operations for Graves' disease was comparatively small, and I hoped that an operation would have benefited her.

The only other case in this series in which I have knowingly operated upon a goitre patient with glycosuria occurred ten months later, when I was obliged on account of dyspnœa to operate upon a lady, age 52, although I did so reluctantly. She had been the subject of diabetes for a considerable time, but treatment (by Dr. Risien Russell) had kept the glycosuria fairly well under control. The goitre was an adenoparenchymatous one causing much tracheal pressure. After a week of strict dieting in the home under Dr. Russell, resection-extirpation of the left lobe of the goitre was performed. This case ran a perfectly normal course, and the wound healed by primary union without any trouble, the patient returning home within three weeks of the operation, completely relieved of all her symptoms except the glycosuria. For nearly four years she remained quite well, although still under treatment for diabetes, and I had the opportunity of seeing her on several occasions. Eventually, while on a visit to Scotland, she suddenly developed diabetic coma, and died in less than a fortnight.

No. 925 was a hospital case, a married woman, age 41, in an early stage of pregnancy, sent to me by Dr. Falkner, of Fulham. For many years she had had a large bilateral adenoparenchymatous goitre which in a previous pregnancy, terminating in miscarriage, had caused much trouble. Her temperature was 100° and her pulse 110–112 before operation. As she had considerable dyspnœa, it was thought best to operate upon her at once rather than to wait many months until the end of the pregnancy, during which the dyspnœa would have got much worse. The operation, which involved removal of 10½ oz. from the right lobe and a small portion of the left, was a straightforward one. She got up, as usual, on the day after the operation, and for six days appeared to be doing well. Her temperature then began to rise. The wound was partially reopened in the middle,

Table IX.—

Case No.	Date of Operation	Private or Hospital	Name	Age	Nature of Goitre and Operation
	SIMPLE GOITRE.				
757	30/1/1913	Private	Miss K. P.	40	Recurrent solid adenoma. Resection-extirpati lobe
925	11/5/1914	Hospital	Isobel R.	41	Adenoparenchymatous, right and left ..
	EXOPHTHALMIC.				
843	20/10/1913	Hospital	James S.	50	Solid exophthalmic goitre. Extirpation rig middle. Local anæsthesia, with a little genera
1076	4/3/1918	,,	Bessie M.	31	Solid exophthalmic goitre. Extirpation right. anæsthesia
1103	17/6/1918	,,	Lottie B.	37	Solid exophthalmic goitre. Extirpation right after 2 previous ligations by another surgeon t previously). Local anæsthesia
	MALIGNANT AND PAPILLIFEROUS.				
1048	21/7/1916	Private	Miss J.	54	Recurrent papilliferous carcinoma. Extirpati with resection common carotid artery and jugular vein
1086	30/4/1918	Hospital	Eliz. N.	50	Bilateral adenoparenchymatous and intrathoraci nant mass

some sepsis having occurred. Symptoms of pleuropneumonia set in, and of this she died four days later. The patient did not miscarry.

This is the only case of the whole series in which any serious suppurative complication occurred.

Exophthalmic Goitre.—The three exophthalmic cases may be taken together. All were bad cases. In two of them there was more loss of blood than usual during the operation. In the other case (No. 843), that of an elderly man, the operation itself, although a very severe one, was not attended with any unusual difficulty. Unfortunately a very small vein which had escaped notice at the time of the operation continued to ooze after the patient returned to the ward. The wound had to be reopened. The bleeding vein was promptly found and tied after only an ounce or two of blood had been lost, but nevertheless he died soon afterwards. All three patients died of sudden heart failure within a few hours of the operation. It will also be noticed that in two out of the three cases the operation was performed wholly or mainly under local anæsthesia. This may be noted by those who consider that the use of local anæsthesia is the main factor of success in operations for exophthalmic goitre.

Malignant and Papilliferous.—No. 1048 was the last of five operations for papilliferous carcinoma. As the long history is characteristic of this class of tumour, it may be given in some detail.

This lady, then aged 43, first consulted me in December, 1905, for a right-sided thyroid tumour which had been present for twenty years but had grown considerably in the last four or five years. In January, 1906, I removed the tumour, which was soft, solid, encapsuled, and as large as a goose's egg. It was thought to be an ordinary adenoma. It recurred and was again removed in 1908 and 1912, the tumours being soft, papillary, and very vascular. On the last of these occasions, definite microscopic evidence of its carcinomatous nature was for the first time obtained (by Dr. Ernest H. Shaw). The tumour at this operation was as large as a man's fist. The fourth operation was in 1913 for a recurrent tumour as large as a hen's egg. In 1915 it had again recurred, but, owing to my absence from England on war service, I had no opportunity of

OPERATION.

OF IE ED	BEFORE OPERATION	AFTER OPERATION
z.	*Glycosuria.* Pulse 120 to 140. Emaciation	Death from double pneumonia 24 days after operation. No suppuration
.	Dyspnœa. Pregnant. Temp. 100°, pulse 112	6th day, suppuration. 10th day, death from pleuro-pneumonia
,	Dyspnœa. Emaciation. Pulse 120 to 124	Recurrent hæmorrhage from very small vein. Death cardiac failure 3 hours after operation.
,	Dyspnœa. Restlessness. Pulse 120 to 140	Death cardiac failure 21 hours after operation
,	Mitral regurgitation	Death cardiac failure 11 hours after operation
,	4 previous operations on same tumour in 11 years	Died soon after operation
	Extreme dyspnœa. Cyanosis	Died immediately after operation

seeing her again until 1916, by which time it had attained formidable dimensions, occupying most of the right side of the neck. Had it been an ordinary carcinoma, I should not have attempted its removal; but knowing its history and papilliferous nature, and having successfully removed a very much larger one of similar nature from a much older patient in 1908,* I hoped I could again make a satisfactory removal in this case also.†

The tumour was not attached to the trachea, and was cleared without much difficulty above, below, and on either side. But at the back, when it was much too late to abandon the operation, it was found that the main carotid vessels were hopelessly incorporated in the tumour and had to be extensively resected. The tumour after removal weighed 14 oz., and was carcinomatous throughout. Some glands were also involved.

No. 1086 was a case of erroneous diagnosis: it was really a case of intrathoracic malignant disease unconnected with the thyroid, and the goitre operation had little or nothing to do with the death.

The woman had been sent up from a village in Lincolnshire suffering from extreme dyspnœa and with a history of an old goitre which had become much worse lately. When admitted she was livid, sweating, and apparently dying of suffocation. She had a deep-seated bilateral parenchymatous goitre of considerable size low down in the neck; the patient was operated upon as soon as possible under local anæsthesia, becoming completely unconscious soon after the operation had begun. The lower portion of each half of the goitre was rapidly removed without any special difficulty. No relief whatever being afforded, tracheotomy was performed and a long tube inserted, with equally little benefit. Far down in the mediastinum, near the bifurcation of the trachea, a hard irregular mass of growth, evidently malignant, could be felt with the finger. It was obvious then that this intrathoracic growth was the main cause of the trouble, and not the goitre. Unfortunately no post-mortem examination was permitted, and the exact nature of the growth must remain in doubt. Had the patient been able to give a better account of her previous history, or had a more thorough examination of the chest been made, and especially if an *x*-ray photograph could have been taken, no operation would have been done.

*Case published and figured in Lettsomian Lectures, *Med. Soc. Trans.* xxxvi, 198.

† It is but fair to her doctor (Dr. Collard, F.R.C.S., of Croydon), to say that he believed the tumour to be irremovable, and the sequel proved him to be right.

XI. LATE RESULTS OF OPERATIONS.

All goitre patients are asked to report themselves in person or by letter one year after the operation, and most of them do so. Many have been seen yearly. But in the last seven months an attempt has been made to ascertain definitely the present condition of each patient, and *Table X* shows the source of the information thus obtained.* I take this opportunity of thanking all the doctors and others who have been good enough to write to me.

In 30 cases, including of course the few that died, the latest information dates from some period before 1920, and in 14 I have been unable to trace the patients after they had left the hospital or nursing home. These last 14 were all quite well when last seen, and I have no reason to suppose that they are not all quite well at the present time.

Table X.—Sources of Information of Late Results.

Traced in 1920 (May to December):—		
By personal observation	109	
,, letters from doctors	191	
,, ,, ,, patients	130	
,, ,, ,, relations, friends, etc.	26	
	——	456
Traced before 1920:—		
By personal observation	13	
,, letter from doctors	11	
,, ,, ,, patients	2	
,, ,, ,, relations, etc.	4	
	——	30
Untraced since leaving hospital or nursing home (all primary union) ..		14
Total		500

The most important table of this paper is the following, which gives a full summary of the information obtained as above described.

Table XI.—Late Results.

Simple Goitre (Operations 408: Patients 406).			
Quite well			342
Quite well after subsequent operation on thyroid elsewhere			3
Not well ,, ,, ,, ,, ,, ...			1
Well as regards goitre, but since undergone other major operations (amputation of breast, hysterectomy, etc.)			3
Well as regards goitre, but with other symptoms, mostly minor:—			
Become very stout	2		
Stomach troubles	4		
Uterine ,, ...	2		
Nervous ,, ...	2		
Cardiac ,, ...	5		
	——	15	
Well until occurrence of other fatal illness or injury unconnected with thyroid operation. (*See Table XII*, p. 451)	9		
Spasmodic asthma until occurrence of other fatal illness or injury unconnected with thyroid operation. (*See Table XII*) ..	1		
Condition unknown until occurrence of other fatal illness or injury unconnected with thyroid operation. (*See Table XII*) ..	2		
	——	12	
Well, but with enlargement of opposite lobe: causing trouble ..	5		
,, ,, ,, ,, ,, ,, not causing trouble	4†		
	——	9	
Well, but with local troubles:—			
Paralysis of vocal cord subsequent to operation ..	3‡		
"Dragging sensation in throat"	2		
	——	5	
Died of operation		2	
Untraced since leaving home or hospital (well and wounds healed then) ..		14	
		——	406

* A large number of those from whom I received information by letter were also subsequently seen and examined by myself.

EXOPHTHALMIC GOITRE (Operations 79 : Patients 78).

Practically well	53§	
Much improved	18§	
Improved	1	
No improvement	2	
Worse	1	
Died of operation	3	
Untraced	0	
		78

MALIGNANT AND PAPILLIFEROUS GOITRE (Operations 13 : Patients 12).

Living and quite well after years : $7\frac{1}{2}$, $2\frac{1}{4}$, 2, $1\frac{1}{4}$, 2	5	
Fairly well with recurrence ,, ,, $1\frac{1}{2}$	1	
Died subsequently of recurrence ,, ,, 1, $\frac{2}{3}$, $\frac{2}{3}$, $\frac{1}{4}$	4	
Died of operation	2	
		12
		496
Add those operated upon twice		4
Total		500

† Probably many more not recorded.
‡ Possibly some others not recorded.
§ 2 died subsequently of other causes.

This table explains itself and requires but little additional comment under the three main heads.

Simple Goitre.—It will be seen that, with but few exceptions, all the patients are well. Most of them have not only been relieved completely of all the trouble from which they suffered before the operation, but enjoy much better health than formerly. I have a large bundle of letters from patients expressing the utmost gratitude for the benefit they have derived from the operation. The following is a representative selection :—

No. 771. A woman, seven years after the removal of a cystic adenoma at the age of 23, on account of dyspnœa, writes : " I have never felt so well as I have done in the last seven years ".

No. 777. Another woman, seven years after operation at the age of 46, for dyspnœa and palpitation, writes : " My general health has never been better in every way than since I had the operation for goitre. I am quite well at the present time ".

No. 827. A district nurse, seven years after removal, at the age of 49, of 8 oz. of goitre, for dyspnœa and palpitation, writes : " I have never had a day's illness since I left the hospital. I have been working hard ever since. I never get palpitation, and I can walk for miles without the least exhaustion ".

No. 838. A gentleman, seven years after removal for dyspnœa, at the age of 67, of a 5-oz., much calcified, adenoparenchymatous goitre, writes : " Before the operation, life was really not worth living ; now it is a pleasure to live ".

No. 911. A lady, six years after bilateral resection-enucleation, at the age of 42, of an adenoparenchymatous goitre, for dyspnœa, writes : " I have not had the slightest return of the symptoms which distressed me so much before. I am infinitely better in health, and I think I am more regularly and consistently energetic than I used to be ".

No. 1074. A girl, three years after a bilateral resection-extirpation, at the age of 14, of 11 oz. of parenchymatous goitre, for dyspnœa, writes : " I am in the best of health and never feel anything of my throat ".

No. 1101. A lady, two and a half years after bilateral removal of an adenoparenchymatous goitre, for dyspnœa at the age of 27, writes : " I am quite well and in splendid health ".

No. 1114. A gentleman, two years after bilateral resection-extirpation, at the age of 19, of $23\frac{1}{2}$ oz. of parenchymatous goitre, for dyspnœa and great deformity, writes : " From the time you operated on me, I have been a new man. I have been able to take part in the most strenuous of outdoor games, a thing I was practically unable to do for a number of years previously. The effect of the operation has been wonderful, and has resulted in a complete cure, for on no occasion have I ever felt any ill effects whatsoever. Sometimes I almost forget that once I had a goitre ".

No. 1133. A lady, two years after removal for dyspnœa, at the age of 34, of an adenoparenchymatous goitre weighing $3\frac{1}{2}$ oz., writes : " Quite well and a very different woman from what I was before the operation ".

No. 1144. A woman, two years after bilateral removal, at the age of 57, for tachycardia and slight dyspnœa, of an old adenoparenchymatous goitre of 5½ oz., writes: "I am delighted to inform you what a great difference in my life the operation has made; the exhausted feeling is gone. I am gaining in weight, although leading a very busy, active life".

FIG. 304.—No. 760. Recent scar, showing the usual low collar incision, in a position where the scar can easily be hidden by a necklace. F., age 47, after removal of a solid adenoma of the right lobe weighing 6 oz. (Scar shown is too thick, but has been chosen because it shows up better in the photograph.)

FIG. 305.—No. 1090. Similar scar 2¼ years after bilateral extirpation of adenoparenchymatous goitre weighing 4¾ oz. F., age 29.

FIG. 306.—No. 1020. A similar scar 4½ years after extirpation of left lobe and isthmus. F., age 36.

No. 1168. A gentleman, one and a half years after removal, at the age of 54, of an old cystic adenoma weighing 14 oz., for bulk and deformity, writes: "I am quite well; the operation has been a complete success and I have been quite a different man ever since".

No. 1169. A woman, one and a half years after a bilateral removal for dyspnœa, at the age of 40, of a goitre weighing 5½ oz., writes: "I am now feeling better than I have ever felt before. I did think at one time that I could not live long. As I could not breathe life was not worth living, but now I can breathe freely".

No. 1195. A lady, fifteen months after removal, at the age of 38, for discomfort and slight dyspnœa, of a cystic adenoma weighing 4 oz., writes: "I am wonderfully better than I used to be before my operation. I can do so many things that were quite out of the question before. For instance, I frequently bicycle fourteen miles a day, which would have been an impossible task for me before my operation last year. I can never feel thankful enough to be rid of that terrible goitre after suffering with it for so very many years.

The scar on my neck has almost disappeared, and it is quite unnecessary to wear any beads or anything to hide it now ".

No. 1249. A woman clerk, one year after removal of a small adenoma, at the age of 45, for discomfort, depression, and slight dyspnœa, writes: " My throat is considerably relieved in every way. My general health and vitality are now better than they have been for many years, and I have lost that ever-accompanying depression entirely ".

Exophthalmic Goitre.—I have found that it is very difficult to make a satisfactory classification of the results of operations for exophthalmic goitre, but I think that that shown in the table is fairly accurate. Complete and absolute cure, with no trace whatever of the previous symptoms, is comparatively rare after operations for true exophthalmic goitre. Some palpitation on exertion, or after unusual excitement, and especially some degree of exophthalmos, often a considerable amount, remain in patients who consider themselves to be otherwise quite well. Nevertheless, a large number have been changed from invalids who previously were wretched and miserable to comparatively happy beings able to do a good day's work and enjoy life. Nearly all express themselves as being extremely grateful for the benefit they have derived from the operation. A few are no better, and some remain depressed and miserable. After a tolerably large experience of operations for this class of goitre, the following points have impressed themselves upon my mind :—

That the operation is much more dangerous than most operations for simple goitre with dyspnœa. Even when the greatest care is taken in the selection of the case that is considered suitable for operation, and in choice of operation, its extent, and the manner of its performance (all important points), disasters and failures will sometimes occur.

That many cases, when first brought to the surgeon with a view to the performance of an operation, are wholly unsuitable for any operation at that time.

That many acute cases, unsuitable for the larger operations of hemithyroidectomy, are nevertheless often capable of standing the less dangerous operation of ligation of one or both superior thyroid arteries, and often derive great benefit from this.*

That the condition of the heart, especially as regards the amount of myocardial degeneration, is a very important factor in deciding whether an operation should or should not be undertaken.

Finally, even when the operation has seemed to be most successful and the patient has appeared to be well for a long time, relapse may occur.

As, however, the medical and surgical treatment of exophthalmic goitre is to be the subject of a further communication, it is not necessary to say anything more now on this branch of thyroid surgery.

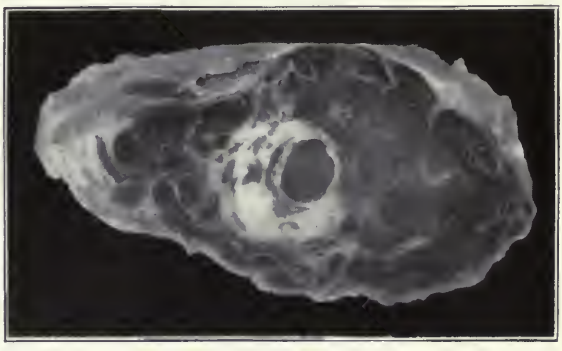


FIG. 307.—No. 1178. Spheroidal-celled carcinoma, removed with glands from F., age 44. Secondary growth appeared on a rib 19 months after operation. *R. Free Hosp. Mus.—Ea. Rb.* 425.)

Malignant and Papilliferous.—The five patients who are still alive and well are the following :—

No. 755. A lady, age 33, who had already undergone an operation at the hands of another surgeon for the removal of an outlying gland, underwent, seven and a half years ago, removal of the right lobe and two separate infiltrated glands in the neck for endothelioma, evidently

* With the subject of ligation of thyroid arteries, this paper, which deals only with cases of *removal* of some portion of the thyroid, is not concerned. Of removal of the thymus for exophthalmic goitre I have no personal experience.

a tumour of low degree of malignancy; she remains quite well and free from recurrence. The primary tumour was about as large as a small walnut.

Nos. 1129, 1146. Two male patients, age 26 and 46, with slow-growing adenocarcinomata, underwent extensive operations, the first involving also the removal of many glands. Both are now, two years later, in excellent health, but the first still has some infected glands which do not trouble him and for which he at present refuses further operation.

No. 1109. A lady, age 47, with a large papilliferous carcinoma of eight years' duration, very similar to the case described on p. 442, is still in excellent health two and a quarter years afterwards.

No. 1140. *Fig.* 286. A woman, age 65, with a small spheroidal-celled carcinoma involving one lobe only, was reported to be quite well when last heard of fifteen months after operation.*

XII. COMPLICATIONS.

Recurrent Laryngeal Nerve Paralysis.—The only complication of the operation, beside those already described, is paralysis of a vocal cord, which is known to have occurred three times. This is an accident which should not occur, but is sometimes unavoidable, especially in cases of large and deep-seated tumours. One case is that of the large intrathoracic tumour described on p. 436.

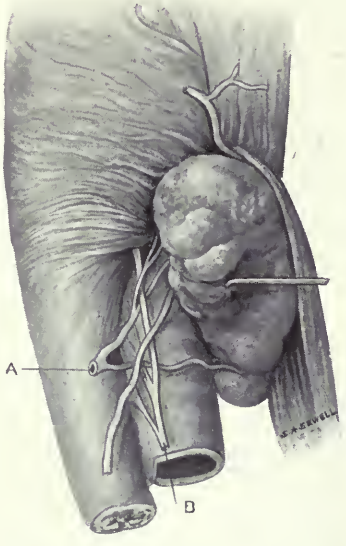


Fig. 308.—Dissection showing recurrent laryngeal nerve (B) and inferior thyroid artery (A). The thyroid gland has been drawn forwards.
(*Dissected by Prof. F. G. Parsons.*)

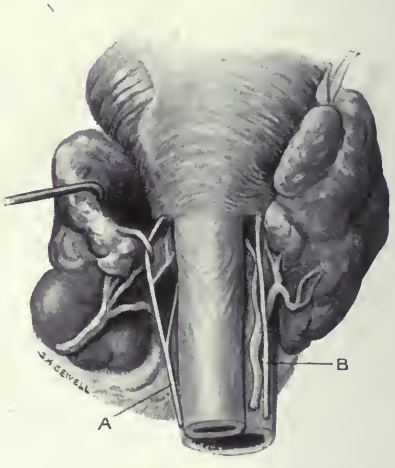


Fig. 309.—Similar dissection seen from behind. On right side the close proximity of the nerve (B) to gland is shown. The left side shows how pulling gland forwards may displace the nerve (A) and render it more liable to injury during an operation.
(*Dissected by Prof. F. G. Parsons.*)

The tumour may displace the nerve from its normal situation, and the best way of avoiding it is to be thoroughly acquainted with the situation in which it is likely to be found, and the alteration which occurs in its position when the trachea is displaced, or when during the operation the thyroid lobe is drawn forwards, as the nerve may be drawn forwards with it. The point at which the nerve is most likely to be cut or clamped is not far below the lower border of the pharynx. It will be seen from the accompanying

* As these sheets are passing through the press (Feb., 1921), further news comes from her doctor that this patient has since died, "presumably of recurrence in the thorax", twenty-two months after operation.

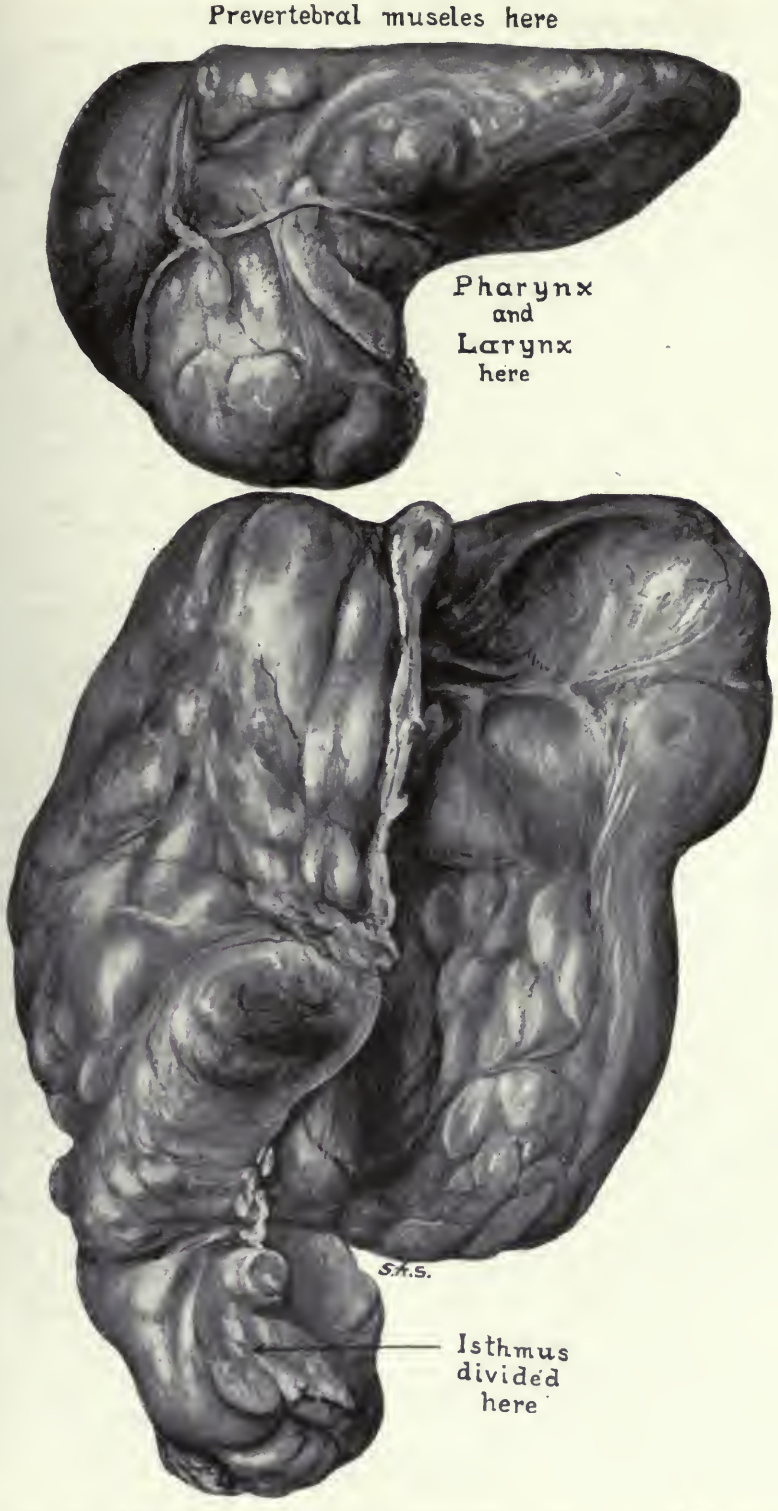


FIG. 310.—No. 1304. A solid, largely retropharyngeal right-sided goitre removed from F., age 44. Weight 11 oz. (*Natural size.*)

drawings of dissections, which have kindly been made for me by Professor F. G. Parsons, and are now in the anatomical department of St. Thomas's Hospital, that the nerve does not lie actually in the groove between the œsophagus and trachea, but a little in front of this. For the acquisition of that correct anatomical knowledge which is so essential for the proper performance of the more difficult thyroid operations, I would strongly urge the study of the dissected preparations of which such large numbers exist in most of our pathological museums, especially the older ones.

The relation of the posterior part of the gland to the pharynx is one of especial importance, since it so frequently happens that this portion of the goitre, especially in parenchymatous cases, extends round behind the pharynx as far as the middle line, or even beyond it. This backward and inward extension may be a source of considerable embarrassment to an inexperienced operator. (See *Figs.* 287 and 310).

Fig. 310 (1304) illustrates an unusual degree of this postpharyngeal extension, and also the fact that a vocal cord paralyzed before operation by the pressure of a goitre will occasionally, although not often, recover after operation. This lady, age 44, was sent to me by Sir StClair Thomson, mainly because of the paralysis of the right cord. She made a rapid recovery, and he tells me that the movements of the cord have now, five months later, been completely restored.

Another patient (No. 785), a professional singer, age 52, from whom in 1913 I removed a solid adenoma weighing 6 oz., partly for dyspnœa but mainly because she was losing her voice, has completely regained it.

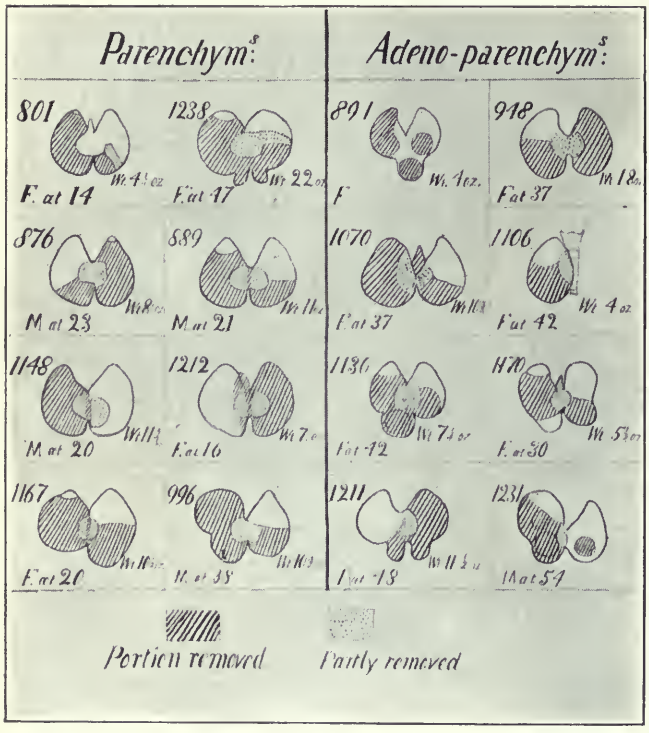


FIG. 311.—Representative diagrams of operations for parenchymatous and adenoparenchymatous goitre, showing amount of gland removed in each case. From rough sketches made by the author immediately after operation.

Thyroid Insufficiency.—With regard to the quantity of gland that should be removed in an operation for goitre, I would say that as little should be removed as will suffice to remove the symptoms for which the operation is undertaken, that the whole gland should never be removed, and that the hilus should be interfered with as little as possible; much must depend on the nature of the goitre and the extent of its degeneration. Myxœdema will then not occur. There has been no marked case of myxœdema after any of my operations, although in a few cases, chiefly of very extensive bilateral removals, the patients have suffered for a time from transient symptoms of thyroid insufficiency, and have been all the better for the administration of a little thyroid occasionally. It should not be forgotten that some goitre patients with much degenerated thyroid gland suffer already to some extent from thyroidal atrophy. With such patients, if operated upon at all, much care must be taken to remove as little as possible of secreting gland tissue.

Tetany.—Although I have up to the present time performed operations for the removal of goitre 1338 times, I have never seen tetany after any of my operations, nor have I ever heard of any case of mine in which it has occurred subsequently. The exact cause of tetany after thyroid operations is still, in my opinion, obscure. The ordinary explanation that it is due to injury of the parathyroid glands seems to me to be not by any means satisfactory.

A mountain of literature has grown up round the subject of the parathyroids, and I must confess myself still an impenitent sceptic as to the supposed separate function of the parathyroids. I never take any special care to avoid them, although I usually do leave a piece of gland at the hilus for many reasons. It may be that, like the famous character in Molière's play, who had been speaking prose all his life without knowing it, I have all along been taking special precautions to preserve the parathyroids without knowing it. The practical point seems to me to be that, provided you leave a piece of gland at the hilus, you need never trouble about the parathyroids at all.

Even if I wished to remove all the parathyroids, I could not be sure of doing so without performing a complete removal of the whole gland, or damaging it so much at the hilus on both sides that it would be practically useless. Besides, even if all four parathyroids could be removed, there would still remain the so-called parathyroid tissue that exists within the gland itself.

Undoubtedly tetany has often occurred after complete thyroidectomy, but this is an operation that I have never in my life performed. I have never seen any case in which I have wished to do this operation, and I doubt whether the necessity for doing it ever arises. It certainly never does in any form of innocent goitre.

XIII. SUBSEQUENT DEATHS FROM CAUSES UNCONNECTED WITH OPERATION.

Table XII.

No.	Sex	Age	Cause of Death	After	Intermediate Condition
SIMPLE GOITRE:—					
814	M.	70	"Bronchitis and heart" ..	3 years	Not known
951	F.	57	"Heart dropsy"	4 ,,	"Wonderfully well"
881	F.	22	"Bright's disease	2½ ,,	Well (married)
840	M.	37	"Some acute illness" ..	6 ,,	Well
864	F.	52	Diabetic coma	4 ,,	Well but diabetic
887	F.	51	Carcinoma, breast	3½ ,,	Not known
930	F.	63	,, œsophagus ..	¾ ,,	Not known
927	F.	40	Cause unknown	3–4 ,,	Well
889	M.	21	Killed in battle	3 ,,	,,
820	F.	43	Run over	7⅓ ,,	,,
811	F.	32	Childbirth	½ ,,	,,
1156	M.	26	Spasmodic asthma	1½ ,,	Asthmatic
EXOPHTHALMIC:—					
847	F.	40	Violence	7/12 ,,	Ill of exophthalmic goitre
851	F.	20	Acute influenza	6 ,,	Well
867	F.	25	Acute rheumatic fever ..	4 ,,	,,
1225	F.	37	Heart disease	7/12 ,,	Much improved
MALIGNANT:—					
754	F.	40	Recurrence of carcinoma ..	1 ,,	Gradually getting worse
950	F.	50	,, .. ,, ..	⅔ ,,	.. ..
1040	F.	59	,, .. sarcoma ..	½ ,,	.. ..
1198	F.	54	,, ,, ,, ..	¼ ,,	,, ,,

If the after-history of any series of 500 persons, whatever be the matter with them, is traced over a long period of years, it will be found of course that some have died. *Table XII* shows, as far as any mere table can show, what I believe to be correct, namely, that none of the deaths in it are in any way attributable to the operation for goitre.

INTESTINAL STASIS FOLLOWED BY CYSTIC DILATATION OF THE CÆCUM, WITHOUT INTESTINAL OBSTRUCTION.

By W. G. SPENCER, London.

WITH PATHOLOGICAL REMARKS ON CYSTS AT THE ILEOCÆCAL VALVE AND ON THE CÆCUM EXCISED, WITH A CONTRIBUTION TO THE PATHOLOGY OF INTESTINAL STASIS.

By ARTHUR KEITH,
Conservator of the Museum, Royal College of Surgeons of England.

I. DILATATION OF THE CÆCUM INTO A LARGE CYST WITHOUT INTESTINAL OBSTRUCTION.

Miss R., age 44, was for a number of years on the nursing staff of the Westminster Hospital; latterly she had been engaged in district nursing, and had continued on duty until a few days before the operation. She had always been spare and a small eater; she had been troubled by constipation, and had had at times attacks of colicky pain. On one occasion she was medically examined, and as there was then tenderness in the ileo-cæcal region, the existence of appendicitis was suggested; but the tenderness passed off without any concomitant symptoms. The abdomen had become slowly distended; this had not been noticed for longer, certainly, than six months, and serious attention had only been directed to it during the previous few weeks.

It was generally concluded, on her admission, that she had an ovarian cyst. I examined her fully both before and after the bowels had been moved three times following the administration of an aperient and an enema; moreover, there was no alteration in the abdominal tension after she was anæsthetized.

The abdomen was distended by an elastic swelling which bulged forwards; it was dull to percussion, and a well-marked wave was transmitted across it. The line of dullness reached midway between the umbilicus and xiphoid cartilage, the upper margin varying with respiration. The flanks were flat and tympanitic; a finger in the rectum did not reach the cyst.

An incision in the middle line of the hypogastrium, commencing a little below the umbilicus, exposed the wall of a cyst, bluish in colour; the index finger passed round between the cyst-wall and the parietal peritoneum met with no adhesions. A large trocar was then plunged into the cyst, whilst the wall of the cyst was seized on each side of the trocar with toothed clamp forceps. It is important to note here that the perforation of the cyst-wall was made in the middle line of the abdomen, half-way between the umbilicus and the pubes. All the fluid escaped at once through the trocar into a bucket; none leaked beside the trocar; within a minute a completely emptied thin-walled cyst was sucked tightly around the trocar owing to the siphonage.

The empty cyst being partly drawn outwards, contracted coils of intestine were noted on the inner side, and the wall of the cyst presented muscular fibres. Search was now made on the outer side and to the right along the line of junction between the parietal and visceral peritoneum. The appendix was first shelled out, some six inches in length, the tip extending over the brim of the pelvis, where it was firmly fixed by a dense band. Tracing the appendix in the reverse direction, it was found continuous without any kink, with an infundibulum which opened into the cæcum, close to where

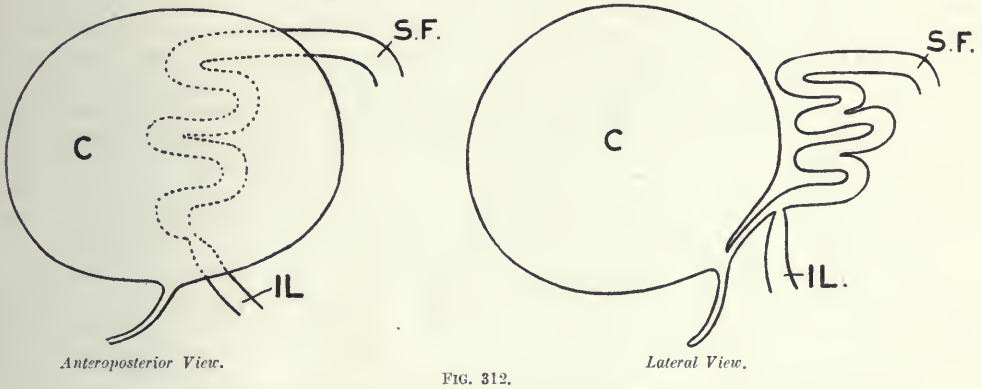
the puncture had been made. It was only then that the nature of the cyst was disclosed. Above what had formed the cyst-wall was the colon, convoluted concertina-like, obscured by fibrous adhesion. To the inner side and behind, the termination of the ileum was continuous with the colon.

The further progress of the operation reduced the cystic dilatation of the cæcum and the convoluted colon into a featureless tube (*Fig.* 314). Beforehand the ileocæcal valve was continuous with the ascending colon above the limits of the cystic dilatation. The communication did not appear to be like that form of intussusception in which the ileocæcal valve heads the intussusceptum. One may compare the state before operation to that existing in the stomach of a ruminant, in which, whilst the rumen is distended, fluid may pass from the cardiac to the pyloric end along a tube formed by muscular contraction which shuts off communication with the rumen for the time being.

Fig. 312 suggests an explanation of why there was no intestinal obstruction.

The cæcum which had been dilated, and the convoluted colon, were now shelled out, whilst mesocolic blood-vessels were secured, after which the end of the ileum together with the ileocæcal valve was implanted into the transverse colon a little on the proximal side of the splenic flexure.

After this the interior of the abdomen was inspected and palpated. The viscera were seen to be veiled, as if by a single layer of gauze; only the anterior surface of the



Anteroposterior View. *Lateral View.*

FIG. 312.

C, Cæcum dilated into a cyst: IL, Ileum continuous through the ileocæcal valve with the convoluted colon. S.F., Splenic flexure of colon.

stomach and the liver showed glistening peritoneum. The viscera were palpated in turn and found normal; in particular all the small intestines were contracted; there were no U-shaped loops. The gauze-like veil of fibrous tissue over the viscera was doubtless the result of mechanical friction by the cyst wall. The bowels were moved on the following day. Later, a series of *x*-ray photographs after a bismuth meal afforded evidence of free intestinal movement through the ileocolic anastomosis.

The patient was examined six months after the operation. She had gained 1½ stone in weight; had improved in colour, having been free from constipation, indigestion, and flatulence; and was about to resume work. Apart from the abdominal distention, the patient had been relieved from the effects of constipation.

The Fluid Contained in the Cyst.—The fluid was all collected, and measured 7½ pints (4·25 litres). It was a uniformly thin dark-brown fluid, brightly glistening from cholesterin, without any solid particles such as fibrin or viscid material. It was entirely without fæcal odour, yet it was noted at the time of dividing the end of the ileum that its contents were yellowish and had the characteristic odour; the end of the divided colon contained brown fæces.

The fluid was immediately examined by Dr. Braxton Hicks; he noted red blood-corpuscles in all stages of decomposition; there was abundance of cholesterin crystals,

but no micro-organisms were seen. As the fluid had all been collected in an open bucket and soon began to decompose with a foul odour, no further examination was made.

It is clear from the clinical history, the tension of the cyst unaltered by the administration of the aperient, and the character of the fluid, that it had been slowly formed by the wall of the cæcum shut off from the colon. Questioned after the operation, the patient could not remember any interruption in the slow enlargement of the abdomen, nor any escape of fluid with her motions.

Supposing—as a result of constipation and a degree of intestinal stasis producing the changes in the wall of the gut described below by Dr. Keith, and the fibrous covering from which the bowel was shelled out—that there was set up an exaggeration of the transverse haustra of the colon, the concertina-like convoluted condition in which the colon was found may be explained. Also this would explain how a constriction at the junction of the cæcum and colon, involving only the peritoneal surface and outer coat, disappeared as the bowel was being removed.

II. PATHOLOGICAL REMARKS.

When first given an account of this case I confidently predicted that the cyst met with would prove to be one situated in the ileocæcal angle of the mesentery, and to be of embryonic origin. A number of these ileocæcal cysts have been encountered by surgeons, but so far no good figure of one has been published. It may therefore be useful to reproduce the accompanying drawing (*Fig.* 313), made from a specimen in the R.C.S. Museum, which was obtained from the body of a full-time, stillborn child. The wall of the cyst shows a lining of mucous epithelium covered by a muscular coat, which has over it a peritoneal covering derived from the anterior layer of the mesentery passing to the ileocæcal junction. The cyst, of the size of a pigeon's egg, has no communication with the lumen of the bowel. Nor have such cysts any morphological significance ; they arise in the latter part of the second month of development as extensions from the epithelial lining of the bowel. Why the ileocæcal junction should be a common site for such embryonic extensions is not known.

The specimen here described, however, proved to have nothing to do with an ileocæcal cyst. The point at which the trocar entered is seen (*Fig.* 314) to be situated in the anterior wall of the cæcum, which in the collapsed hardened viscus is situated 1 in. (2·5 cm.) below and in front of the ileocæcal junction. There thus remains no doubt that the cyst was formed by a greatly distended cæcum.

The cæcum in its collapsed state measures $2\frac{1}{2}$ in. (7 cm.) in length and only $1\frac{1}{4}$ in. (3 cm.) in width. The peritoneal coat had been stripped away with part of the external muscular coat. To the naked eye the muscle of the cæcum showed no departure from the normal save in the broken appearance of its fasciculi. The viscus tapered to a conical apex from which came off a long appendix measuring $5\frac{3}{8}$ in. (13·5 cm.) in length and $\frac{1}{3}$ in. (8·5 mm.) in diameter. From it, too, the peritoneal coat has been stripped away, and also the greater part of the longitudinal coat, thus exposing the circular coat, which is firmly contracted. Sections across the appendix at two points show its lumen to be open, its epithelial lining intact ; five to six follicles are seen in each transverse section, some of these breaking down in the centre. The only marked departure from the normal state occurs in the submucous coat, which becomes densely fibrous where it approaches the inner muscular coat, as if it had been the site of a chronic inflammatory process. The circular muscular coat is healthy. In its present highly contracted state the tract of colon removed measures over 21 in. (54 cm.). The first 4 in. (10 cm.) I regard as representing the ascending colon, the remainder the proximal part of the transverse colon. Along the whole length of this part, the musculature is most irregular in its arrangement and development.

Allowing for the shortened condition into which the tæniæ have been thrown by being preserved in formalin solution, there still remains evidence that there must have been a good deal of hypertrophy in the longitudinal coat, particularly in the tæniæ.

Apparently the ascending colon and the proximal part of the transverse loop were matted together in a confused mass, and in the course of separating the various coils the peritoneal coat was torn away from certain areas and the muscular coat and tæniæ were ruptured in places. At no point is there any localized stricture or obstruction; throughout the colon its breadth varies from 3 to 4 cm. It is the irregular spastic condition of its musculature which seizes one's attention.

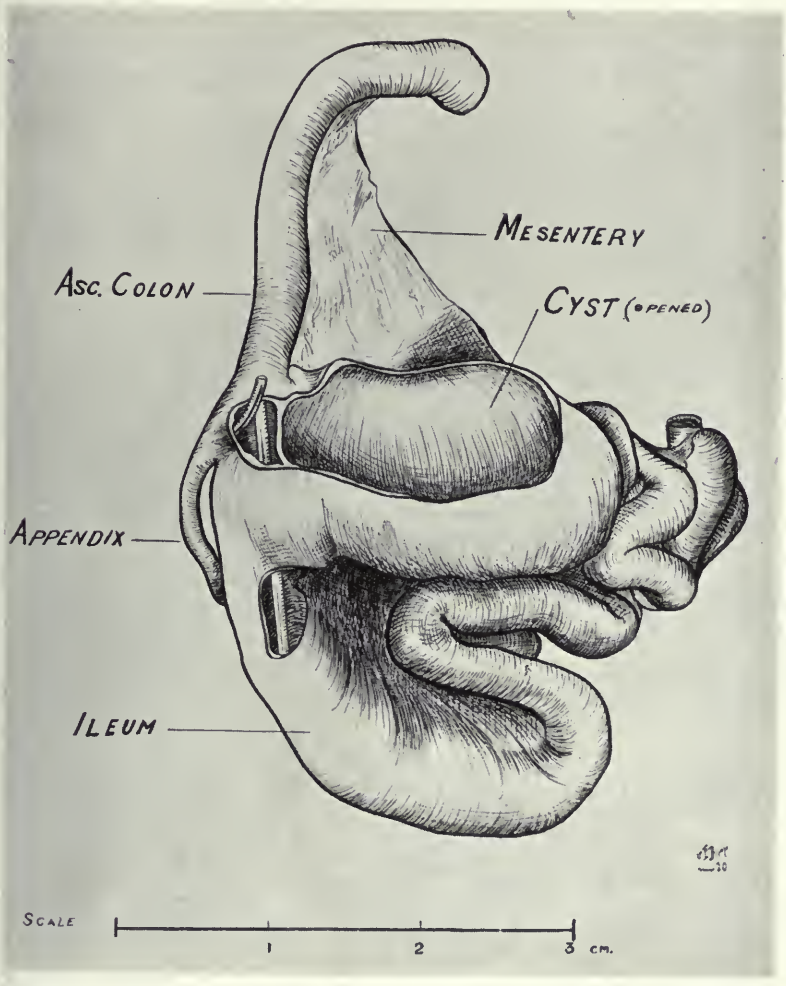


FIG. 313.—Drawing of a congenital ileocæcal cyst removed from the body of a full-time, stillborn child.

Microscopic examinations were made of the wall of the cæcum and colon at several points by Mr. J. Howard Mummery and the writer, various staining methods being employed. Examination of the muscular and mucous coats of the cæcum, which one would have expected to show marks of the enormous distention to which they had been subjected, reveals only minor departures from normal. As may be seen from *Fig.* 315, where a section of the cæcum from this case is compared with a section made from a healthy cæcum, the muscular coats are normal in thickness and arrangement. The outer coat shows some areas of degeneration, but such are not uncommon in cæca which

are counted healthy. The fasciculi of the inner coat are, for the greater part, separated into bundles which, on section, are sickle-shaped and placed widely apart, the separation being the result of the over-distention to which the cæcum has been subjected. The corresponding coats of the colon are thick, dense, and strongly contracted. The preservation of the bowel was not favourable to a minute examination of Auerbach's plexus. In the cæcum, and particularly in the appendix, of healthy normal individuals, this system is more slightly developed than in the colon. In the present instance such nerve-cells as could be detected in the cæcum were irregular and apparently atrophic. In the colon they were normal in number and in form. I am of opinion that a complete and

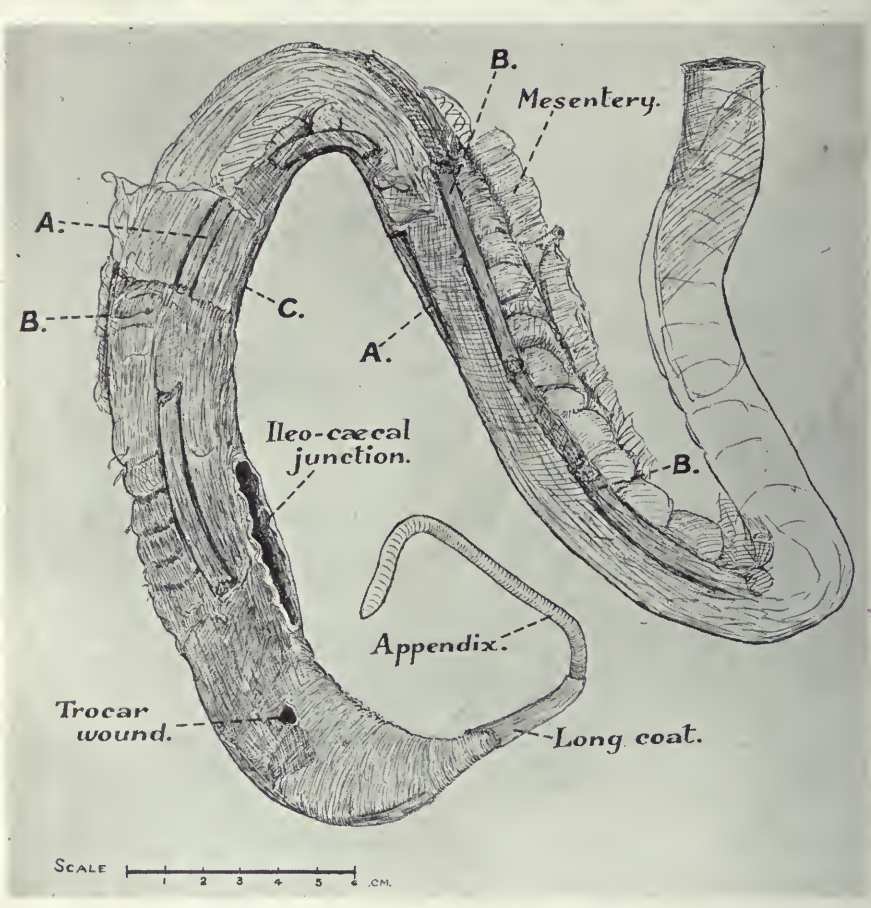


Fig. 314.—Drawing of the part of the bowel removed. The scale of reduction is indicated. A, Anterior or free tænia; B, Omental tænia; C, Mesenteric tænia.

exact examination of the peripheral-nerve system of the cæcum in such cases as this will show degeneration in Auerbach's plexus; but the evidence so far at my disposal is little better than presumptive. The essential pathological state of the bowel excised lies in its mucous membrane.

Certain cells lying between the lower or blind ends of the tubular glands of the mucous membrane are overladen with a brown pigmented substance which Mr. Shattock, Pathological Curator R.C.S. Museum, has observed in cases where the lining membrane of the appendix was blackened by pigment. In this case, the mucous membrane, both

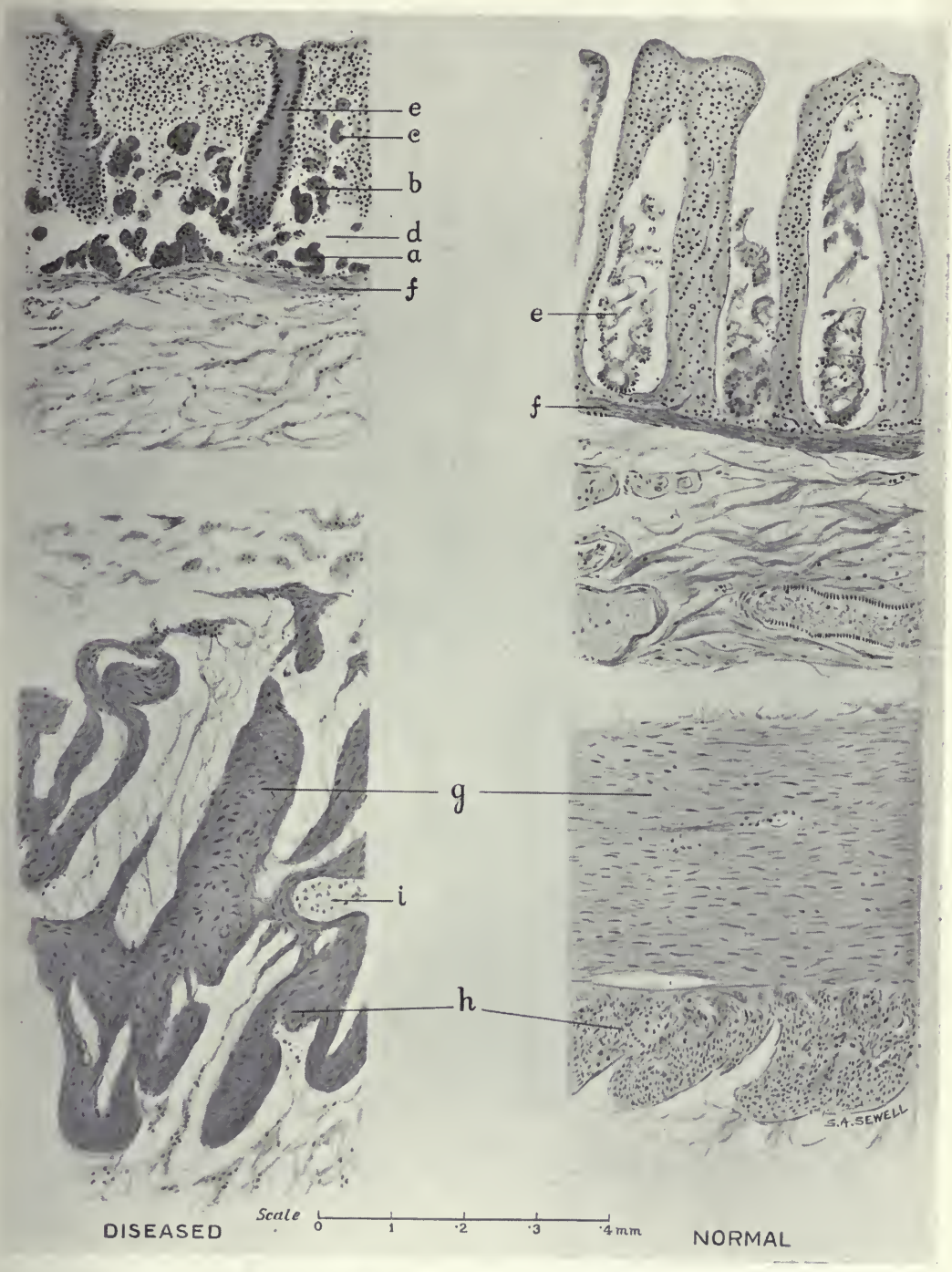


FIG. 315.—Section of the cæcum from this case compared with section of a normal cæcum. *a*, *b*, *c*, Cells laden with brown pigmented substance in various stages of transformation; *d*, Dilated lymph spaces or vessels; *e*, Lieberkühn's gland; *f*, Muscularis mucosæ; *g*, Inner muscular coat; *h*, Outer muscular coat; *i*, Auerbach's plexus.

of the cæcum and colon, is of a dark-brown colour, due to the pigment-laden cells in the deeper stratum of its substance. In recent years I have encountered collections of these cells in a large number of bowels excised on account of 'stasis'; they are said to occur in the intestines of healthy people, but I do not believe this to be true. However, I have never seen such a dense and continuous stratum of cells, overladen with brown pigment substance, as in this case; its abundance in the cæcum is shown in *Figs.* 315 and 316; in

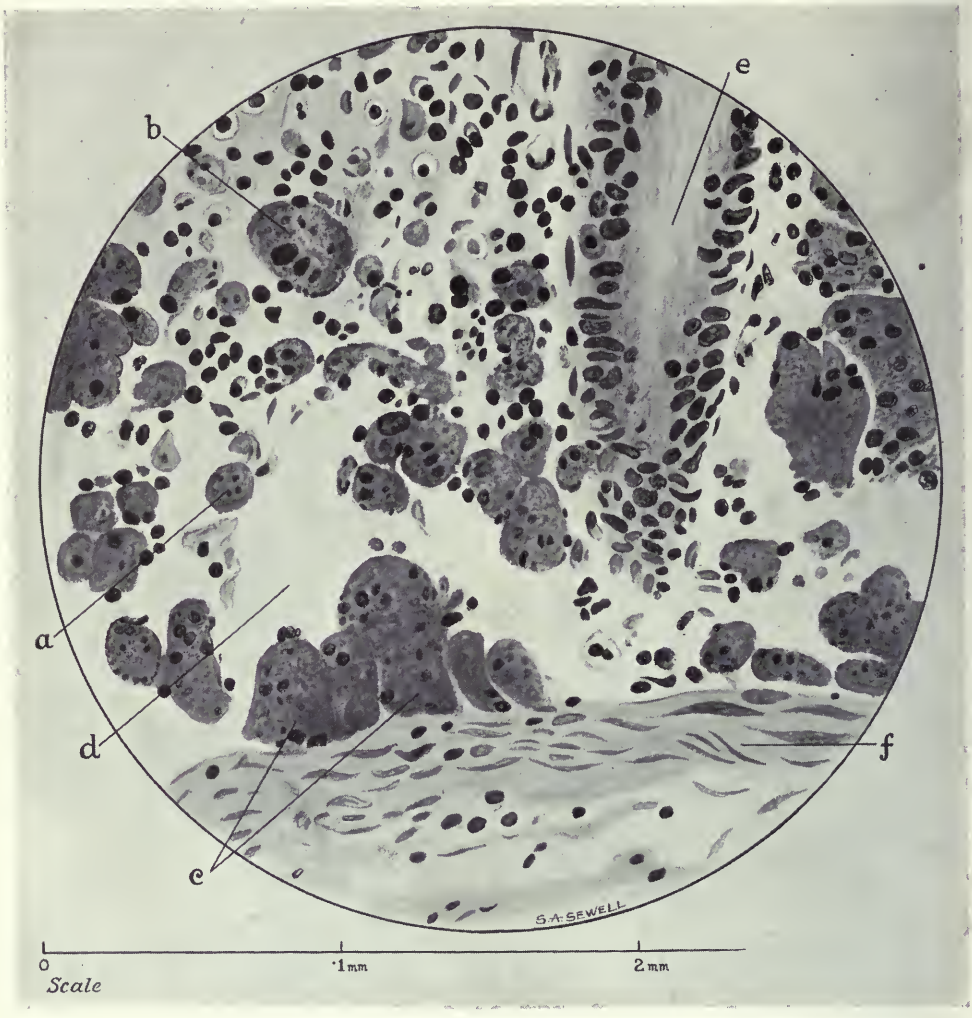


FIG. 316.—Pigment-laden cells, with the surrounding dilated lymph-spaces or vessels, in the cæcum of the case. *a*, Cells laden with brown pigmented substance; *b*, *c*, Groups of such cells in stages of being absorbed; *d*, Lymph space, dilated; *e*, Lieberkühn's gland; *f*, Muscularis mucosæ.

the colon the amount was much more than in the cæcum. A careful study has convinced me that these overladen cells, often distended until they have a diameter of 15 μ, or aggregated to form irregular masses of 40 to 50 μ in diameter, are endothelial in origin; they occur as normal structural constituents of blood-capillaries or of lymph-capillaries. Those lying under the surface of the epithelium of the mucous membrane or between the

more superficial segments of the tubular glands, although pigment can be observed in them, never become overladen and engorged as do the deeper cells placed between the fundus of adjacent glands and just above the muscularis mucosæ. Certain appearances lead one to believe that these cells migrate towards the deeper stratum as they become engorged, but of this I am by no means convinced. Always there are greatly dilated lymph-vessels or spaces around the clumped pigmented cells lying on the upper surface of the muscularis mucosæ; there seems to be a positive obstruction to the outflow of lymph. The lymphatic obstruction must react on and hinder the venous circulation. Around the clumped, pigmented masses are numerous mononuclear lymphocytes which apparently are concerned in digesting and removing the accumulated pigmented débris. I cannot resist the inference that the presence of these large cells, engorged with pigmented matter, are symptomatic of a grave disorder in the economy of the colon.

As to the nature of the brown substance, I refer the reader to recent papers by Salkowski[1] and by Brahm and Schmittmann.[2] They regard it as a waste product, derived from the metabolism of fat, and that the pigment is of the same nature as melanin. There is, in the opinion of the writers just cited, some close relationship between the adrenal function, the motor-nerve plexus of the bowel, and pigment formation. I feel confident that these brown cells are related to the motor disorders of the bowel, and when they occur are indications of the existence of constipation.

My interpretation of the case is that the cystic dilated condition of the cæcum was a sequel to a spastic state in the muscular coats of the proximal colon, as the result of a long-standing intestinal stasis of which the adhesions of the cæcum and appendix are evidence. In certain animals, such as rodents, the cæcum is marked off from the colon by a well-marked sphincter. I have seen many cases in formalin-hardened human bodies where the proximal colon was contracted as if it served as a sphincter. There must be a close functional co-ordination between the cæcum and proximal colon, just as between the stomach and small intestine. In the present instance this co-ordination appears to have broken down. The matting together of the cæcum and proximal colon shows that the patient had suffered for a considerable period from that clinical entity described as intestinal stasis. We are apparently dealing in this case with one of the terminal results of stasis; but in this instance the obstruction in the colon cannot be attributed to any extrinsic cause such as bands or kinks. The condition is one affecting the motor mechanism.

In my opinion the method of preserving the ileocæcal sphincter and valve, and implanting them into the distal colon, has much to commend it from a functional point of view.

REFERENCES.

[1] Salkowski, *Virchow's Archives*, 1920, 227, 121.
[2] Brahm and Schmittmann, *Ibid.*, 137.

THE CLOSURE OF SEPTIC BONE CAVITIES FOLLOWING GUNSHOT WOUNDS BY MUSCLE-FLAPS.

By DUNCAN WOOD, Bristol.

The problem of healing up old discharging sinuses leading down to a cavity in a bone has, for a long time, engaged the attention of surgeons. Since the war, the necessity of solving the problem has become intensified. A large number of ex-soldiers suffer from this complication of their gunshot wound. It not only entails their being absent from their work whilst attending for dressing at local clinics, but the constant septic discharge may, in time, cause lardaceous disease. Af. Schultzen quotes a case where the sinus was discharging for nine years. At the time of operation the patient had albuminuria, which disappeared when his wound was healed ; in my *Case* 16 of the following series, the sinus was discharging for over three years ; albuminuria and anæmia were present, both of which cleared up after the operation.

This paper is based upon a series of twenty-four consecutive cases. The average time the wounds had been discharging was two years and eight months. Three cases had a persistent sinus for over four years. This is the type of chronic sinus leading down to a cavity in a bone, for which the operation to be described is advised. The difficulty of closing these cavities is shown by the numerous methods advocated.

1. Schede's aseptic blood-clot is the simplest of all, but a completely aseptic condition of the tissues must be procured, otherwise the blood-clot acts as pabulum for the bacteria present.

2. The insertion of substances such as solidifying paraffin, and Senn's decalcified bone-chips. These substances have no bactericidal power. When placed in cavities following gunshot, the wound tends to break down on the fourth to eighth day, and the contents become exposed, and slowly extrude.

3. Antiseptic plugs, such as Beck's bismuth paste, and Rutherford Morison's B.I.P.P., tend to counteract the septic conditions. But in large cavities a considerable quantity of the paste will be required, and may lead to poisoning by absorption.

4. Von Eiselsberg's osteoplastic flaps method, and Af. Schultzen's crushing in of the bony wall of the cavity, are unnecessarily severe. Massive necrosis of the bone has followed the latter method. Af. Schultzen, whilst recommending it for the upper end of the tibia, agrees that it is too destructive for single bones like the femur.

5. Broca advised the removal of so much bone that the soft parts would fall into the resulting depression of their own accord. Unless the cavity is very shallow, this method requires the removal of too much bone. Especially does this apply in the case of single bones, such as the femur and humerus. I was unfortunate enough, when attempting this technique, to fracture the femur. This finally led to the amputation of the limb. If a large quantity of bone is not removed, the overlying structures will be under tension if forced into the cavity. Again, the tissue will not fit the cavity as accurately as by a specially-cut flap of muscle.

6. Walton Martin advocates the use of fat-grafts to pack into bone cavities. He states that the fat splits into fatty acids and glycerin within the cavity, and that these do not readily support bacterial life. The fat-graft does not appear to have an active bactericidal action. He depends on three weeks' treatment by the Carrel-Dakin method, applied between the two stages of the operation, to procure asepsis. He only reports one case of a cavity due to gunshot wound, and this required three separate operations. It is simpler to produce relative asepsis in a cavity following tuberculosis or the later stage of osteomyelitis, than in those following gunshot wounds. Lefevre has tried this method

of fat-transplants, and quotes three failures due to the impossibility of rendering the cavity sterile.

7. The idea of filling up the large cavities with pedicled flaps of the soft tissues is not new. Af. Schultzen reported twenty cases operated on by him at Helsingfors in 1894. The cavities were the result of chronic, following on acute, osteomyelitis. His flaps consisted of deep fascia, muscle, and periosteum, with fragments of bone sometimes attached to the latter. The use of a flap of muscle to fill cavities following gunshot wounds has been advocated by Percy Sargent, Elmslie, and Lefevre. Its advantages are that for a successful result the bone cavity need not be absolutely sterile. Those who have been called upon to treat old-standing discharging gunshot wounds will appreciate the difficulty of making them aseptic. The pedicle muscle-flap is a living plug with its own blood, and often its

FIG. 317.—*Case* 17. Cavity in upper third of femur, filled with vastus externus by two-stage operation.

FIG. 318.—*Case* 13. Lateral view of lower third of femur before operation. Semimembranosus used to fill cavity.

own nerve-supply. It is consequently able to resist low degrees of infection. This is a great advantage over the other methods mentioned above. The use of muscle as a hæmostat is well known in brain surgery. Its similar action in bone cavities is of great importance. It prevents the accumulation of blood-clot, which would act as a pabulum for organisms in the wound.

If an abscess is present in the soft tissues, drainage of the abscess should be done as a preliminary to the main operation. In *Case* 7 the patient was admitted with this complication and a temperature of 103°. The abscess was drained and Carrel-Dakin

treatment carried out for twenty-five days. At the end of this time the bacterial count showed two cocci per field. A successful muscle-flap operation was then performed.

TECHNIQUE OF THE OPERATION.

The first step is to open up the cavity in the bone, and the second to place in that cavity a pedicled muscle-flap. These two steps are preferably done at one sitting, and this also applies if a sequestrum is found in the cavity. Sargent, Elmslie, and Lefevre also complete the two stages without an interval. Af. Schultzen advocated an interval of two to three weeks between the two steps. In the first he enlarges the bone cavity and

FIG. 319.—*Case* 18. Tunnel type of cavity. Probe points to cavity in lower third of femur. Quadriceps used as muscle-flap.

FIG. 320.—*Case* 15. Gutter type of cavity in femur. Filled by vastus externus.

leaves in a pack. In the second he cuts out and inserts a musculoperiosteal flap. This method was followed in *Case* 17 (*Fig.* 317), as there was a bag of pus found on opening up the cavity. In spite of this, the case is healing, though very slowly.

A tourniquet is not advisable on account of the oozing of blood which may follow its removal. Hæmorrhage into the cavity is not generally an embarrassing feature during the operation. A clear view can be obtained by a temporary tampon of gauze soaked in hydrogen peroxide. Sargent and Lefevre are both against using a tourniquet. Af. Schultzen, on the contrary, advocates its use, but in *Case* 5 of his series the hæmorrhage was so profuse after removing the tourniquet that a tampon had to be left in and the operation completed two days later.

The site of the incision depends upon the position of the sinus present. This may be adjacent to important vessels and nerves. *Case* 13 (*Fig.* 318), with a cavity in the femur, involved dissecting out the femoral artery from the scar tissue. In this type of case Af. Schultzen approaches the cavity through normal tissue on the other side of the limb. The disadvantage of this method is that the scar tissue surrounding the sinus is not touched, causing the final healing to be greatly delayed.

A J-shaped incision is made, with the long limb of the J surrounding the sinus, and the hook of the J curved towards the side from which the muscle-flap will be taken. This side should be that on which most muscle can be felt and least scar tissue is present. In *Case* 23, with a cavity in the head of the tibia, a chronic ulcer with much scarring was excised by a large oval incision, and, after inserting a flap from the inner head of the gastrocnemius, the wound was closed by turning down a skin-flap from the inner side of the thigh. As much scar tissue as possible is excised. This is the most tedious and difficult part of the operation. The periosteum round the cloaca into the bone is stripped back. The space between the muscle and bone is packed off with gauze to prevent pieces of bone, separated by chiselling, being left behind. Sargent emphasizes this point. The entrance to the cavity is then enlarged by the chisel.

FIG. 321.—*Case* 12. Multilocular type of cavity in middle of shaft of femur.

The cavities present are of two types. In the tunnel type (*Fig.* 319) there is a complete opening through the shaft of the bone. The base of the tunnel will be formed of fibrous tissue on the opposite side of the limb. The cylindrical tunnel is turned by the chisel into a funnel. A pyramidal-shaped muscle-flap can then be inserted right up to the apex of the funnel. In the other type (*Fig.* 320) there is only one opening into the cavity; and these are more favourable to treat. The upper and lower lips of the wall of the sinus are removed, so as to turn the cavity into a gutter. The lateral walls are preserved, to retain the cylindrical shape of the shaft of the bone and thus preserve its strength. This is an important variation of Broca's method, in which the cavity must be flattened out.

The cavity may be simple or multilocular. In the latter case (*Fig.* 321) the walls must be smoothed down by a gouge to make one large cavity. This is difficult in injuries like those in *Case* 7 (*Figs.* 322, 323), where there are long fissures running up the shaft of the bone. All granulation tissue is removed from the wall of the cavity. The complete sterilization of the cavity would appear to be impossible. In this series, the earlier cases were treated by cleaning the cavity with methylated spirit, and leaving in a B.I.P.P. pack while the muscle-flap was being cut. All the paste should then be wiped away, or the adhesions between the muscle-flap and the walls of the cavity will be delayed. In the later cases the cavity was washed out with hot saline, as advocated

by Sargent. Lefevre attempted to sterilize his cavities with hot air. All chips of bone must then be carefully sought for and removed from the wound. In a large wound they may easily be overlooked. In *Cases* 8 (*Figs.* 324–326) and 15, local abscesses occurred in the soft tissues shortly after healing of the wound. Both cases were due to a sequestrum lying outside the bone.

The second stage of the operation consists in dissecting back the deep fascia and exposing healthy muscle in the neighbourhood of the sinus. In a patient who had an ankylosed knee-joint, a U-shaped flap, consisting of deep fascia, muscle, and periosteum, as advocated by Af. Schultzen, was used. It was a failure. The flap was too rigid to fit

FIG. 322.—*Case* 7. Lateral view of lower third of femur, before operation.

FIG. 323.—*Case* 7. Anteroposterior view of lower third of femur, showing cavity smoothed out at operation. A double flap was required to fill it.

the cavity accurately, thus leaving dead spaces behind. It also left a space between the skin and the place from which the flap was cut. In all the cases in this series one or two healthy muscle-bellies have been dissected out, and the deep fascia and periosteum have not been used.

The flap should preferably have its base above, as being easier to retain its blood- and nerve-supply. If this is anatomically inconvenient, the base may be made below as in *Cases* 1, 4, 9, and 10. In one of Af. Schultzen's cases, on account of the size of the cavity in the lower end of the femur, it was necessary to cut two flaps—one with its base above, and one with its base below. The inferior base-flap sloughed, the superior base-flap survived. The difference must have been in the blood-supply, and not in the amount

of sepsis present. Campbell and Pennefather have divided the muscles up into groups by their blood-supply. According to this classification, muscles such as the inner head of the gastrocnemius have a unipolar blood-supply. This muscle was used in *Cases* 21, 22, 23, and 24, the flap being cut with its base above. The muscles which were left with a base below have either belonged to the bipolar group, such as the biceps (*Case* 9), or the multipolar group, such as the vastus externus (*Case* 10) and the deltoid (*Case* 1).

The flap should consist of healthy muscle alone. Undamaged muscle is very mobile, and will fill the undulations in the cavity accurately. The length of the flap is cut so as to reach into the bottom of the cavity without tension. The contractile nature of muscle must be allowed for. Two or three catgut sutures fix it in position to prevent its displacement whilst sewing up the wound. If it is properly cut, there should be no tension, which would endanger its blood-supply.

If the cavity is very large (*Cases* 7 and 10) it is necessary to cut a second flap, the double-flap method. One flap is taken from the inner edge, and one from the outer edge of the wound. They may be cut—one with its base above and the other below, as in *Case* 10 (*Figs.* 327–329), or both with their bases above, as in *Case* 7, where the semi-membranosus and the vastus internus were used.

FIG. 324.—*Case* 8. The arrow points to sequestrum left behind at muscle-flap operation.

The situation of the flaps should be such that, when cut, they fall laterally into the cavity. In some cases it is necessary to turn the flap at a right angle, but an acute angle should be avoided, as liable to constrict the blood-supply. For a cavity in the upper end of the humerus the deltoid is chosen, preferably its anterior portion, as less likely to interfere with its nerve-supply (*Cases* 1 and 2). If the cavity is rather low down the humerus, tension of the flap may be avoided by putting the arm on an abduction frame. For the shaft and lower end of the humerus a portion of the triceps is used (*Case* 3). The radius and ulna rarely require this operation. A lesion sufficiently severe to produce a large cavity will usually result in a complete gap in the bone. In *Case* 4 the upper end of the ulna was united by a bridge to the radius. A cavity was left between the lower fragment of the ulna and this bridge. I was filled by a flap cut from the upper end of the extensor carpi ulnaris. This muscle was chosen as least likely to interfere with the function of the hand. For the ilium, the gluteus maximus is usually accessible (*Case* 5). The muscles round the shaft of the femur are very suitable for flaps. They have long bellies, and can be cut to the required length, thus avoiding tension. The vastus externus (*Cases* 6, 8, 10, 12, 14, 15, 16, 17, 18) should be chosen when possible: it is bulky; the action of its whole is not seriously impaired by using part of the muscle; it is not intimately connected with important nerves or arteries—a great help where much scar tissue is present (*see Figs.* 330, 331). In *Case* 11 it was not available, being fibrous and bound down to the femur. The biceps was used to fill the cavity. Just above the condyles the vastus externus is too tendinous to be satisfactory.

A sinus on the inner side of the femur is fortunately much rarer than on the outer side; this is no doubt due to the tendency of surgeons operating on the primary wound to drain on the outer side of the limb. Contact with the femoral vessels was thus avoided

by the large drainage tubes which were used at one period of the war. In *Cases* 7 and 13 the sinus was present on the inner side of the thigh. The semimembranosus was used to close the cavity. The objection to this muscle is its relatively small width. This difficulty was overcome by using a second flap from the vastus internus. Af. Schultzen's method of approaching the cavity from the other side of the femur would have so seriously weakened the shaft of the bone in this case as to be impracticable.

For the upper end of the tibia (*Cases* 21, 22, 23, 24) the inner head of the gastrocnemius is used. It is preferable to the soleus on account of its higher origin. This allows

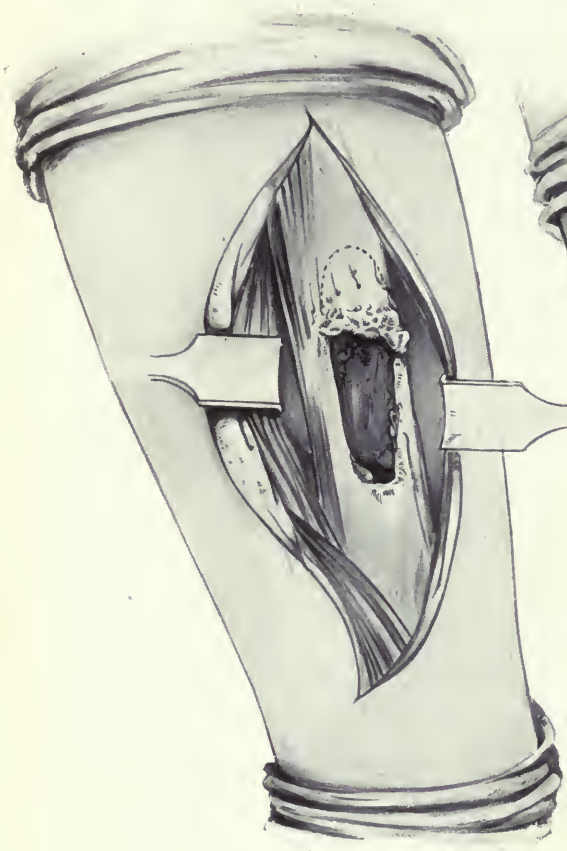


FIG. 325.—*Case* 8. Gutter type of cavity in femur. Dotted line shows amount of bone requiring removal.

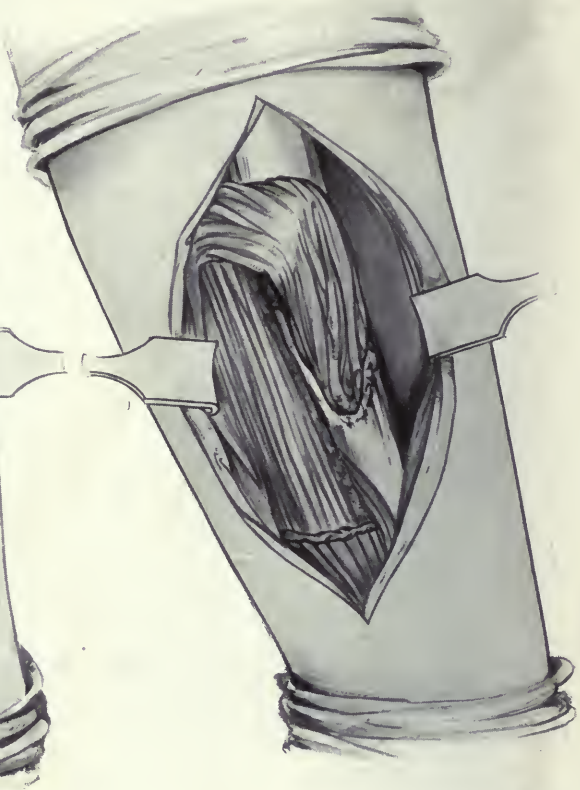


FIG. 326.—*Case* 8. Cavity filled by single flap from vastus externus with its base above.

a more mobile flap to be cut with its base above, the cavity usually being in the head of the tibia. When the entrance is on the outer side of the shaft of the tibia, no muscle is available. The anterior tibial group is not bulky enough, and, on account of its close relation to the bone, tends to be involved in scar tissue. It is necessary to approach the cavity through its intact inner wall; the inner head of the gastrocnemius then becomes available. The resulting weakness to the shaft of the tibia is of less importance than in the femur on account of its fibular support (*Case* 21, *Figs.* 332–335). The cavity being filled with a muscle-flap, a rubber-glove drain is placed on the superficial surface of the flap to allow any exudation to escape. No drain is placed in the bone cavity. The deep fascia is

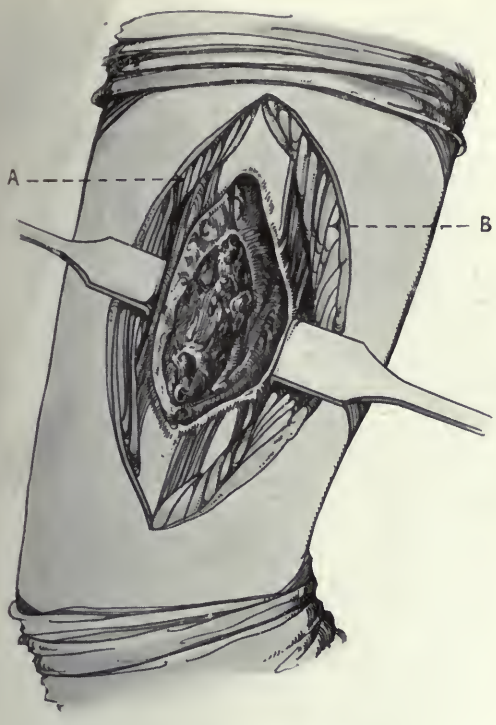


FIG. 327.—*Case* 10. Cavity exposed through outer wall of femur after excision of scar tissue. A, B, Vastus externus.

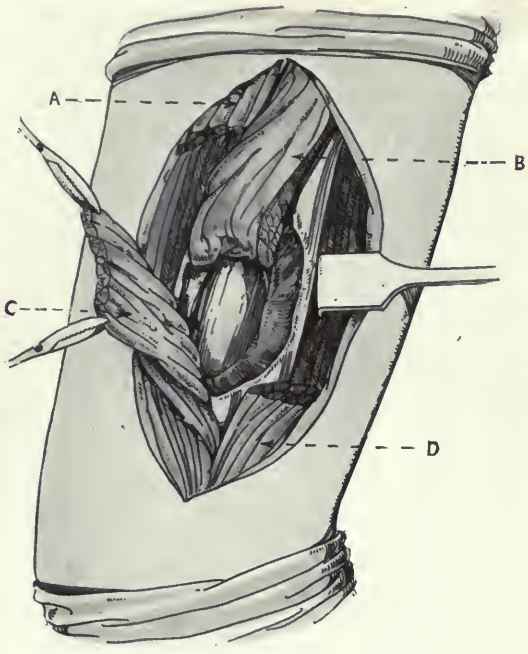


FIG. 328.—*Case* 10. A, C, Cut ends of vastus externus anterior to femur. B, D, Cut ends of vastus externus posterior to femur. The first flap (B) inserted in cavity.

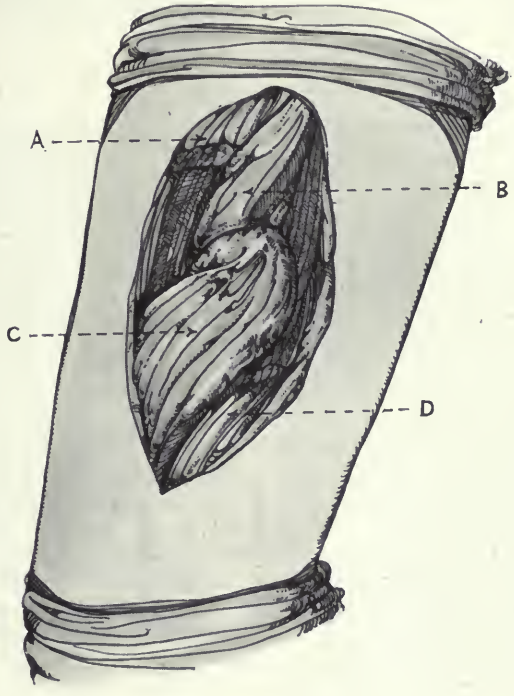


FIG. 329 *Case* 10.—C, The second flap, with its base below, inserted in cavity.

FIG. 330.—*Case* 19. Cavity in outer wall of femur, before operation.

FIG. 331.—*Case* 19. Upper third of femur after operation. Vastus externus inserted in cavity.

FIG. 332.—*Case* 21. Cavity in head of tibia, before operation.

FIG. 333.—*Case* 21. After operation, showing method of approach to cavity for inserting gastrocnemius.

resutured in position by catgut. The skin is closed with silkworm gut. A lightly bandaged dressing of gauze and wool is applied, and a wooden splint for the first four days to keep the neighbouring joints at rest. Af. Schultzen devised a wire cage to stand over the wound to prevent pressure of the dressing causing anæmia of the flap. Probably the reactionary œdema of the tissues inside the limb is more to be feared than light pressure from without.

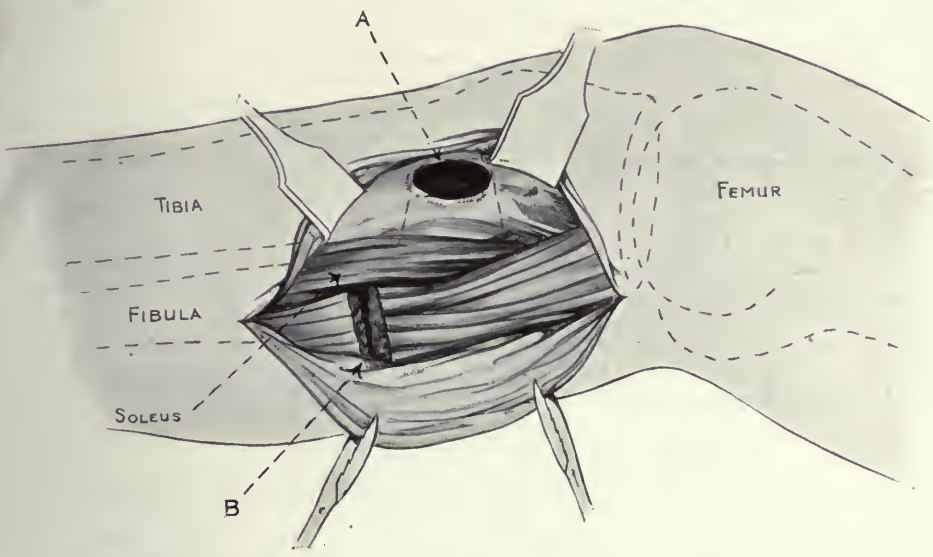


FIG. 334.—*Case* 21. A, Cavity on inner side of head of tibia. B, Flap from inner head of gastrocnemius.

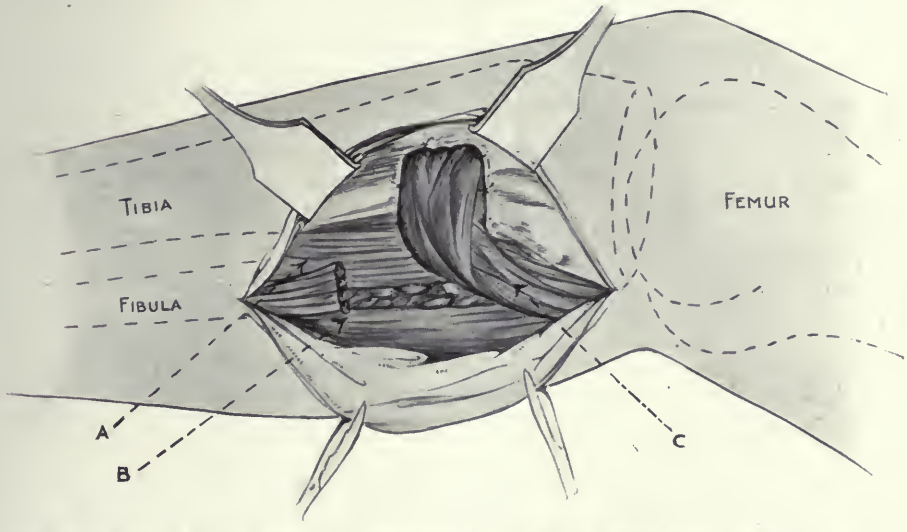


FIG. 335.—*Case* 21. A, Soleus muscle. B, Gastrocnemius. C, Flap from gastrocnemius inserted into cavity.

Lefevre found his best results with the humerus and his worst with the femur. In most cases there is an inflammatory reaction in the wound, at its worst on the fourth day. One or two stitches may require removal. In no case in this series has the flap sloughed. In two instances (*Cases* 11 and 20) the wound healed by first intention.

The average time taken for each operation is one and a half hours.

Bones involved	Cases	Healed
Humerus	3	1
Ulna	1	1
Ilium	1	1
Femur	15	14
Tibia	4	4
Total	24	21

Time of Healing after Operation.

Af. Schultzen gives an average of forty days for each case in 14 cases, the longest being ninety days, and the shortest thirty.

Lefevre, in a series of 53 cases, had 12 healed by first intention, 26 in one month, 3 in six weeks, 4 in two months, and 8 failures.

In my series, the average time was forty days. There were 3 failures, as follows :—

Case 2.—There is still a sinus present, probably due to a small piece of bone left behind. A further exploration will be necessary.

Case 3.—This patient cannot be traced. It is not known whether the wound is healed.

Case 6.—This patient had to leave the hospital for family reasons a few days after the operation. It is probable that the flap became partly dislodged.

Contra-indications to the Operation.

1. If a cellulitis or active inflammation of the muscles round the sinus is present, a preliminary drainage followed by Carrel-Dakin treatment should be given.

2. Excessive wasting of the muscles of the limb. In cases due to gunshot wounds, the wasting is usually only localized, and due to destruction of the muscle by the missile. In old cases of osteomyelitis in children, general wasting of the limb may be a bar to a sufficiently bulky muscle-flap.

3. If no muscle is available locally for anatomical reasons. The lower end of the tibia is the most striking example, but here Broca's method of flattening out the cavity can be done on account of the additional support given by the fibula.

The question arises as to what eventually happens to the cavity after a successful closure by a muscle-flap. It is very unlikely that the cavity ever becomes filled by bone. The lessened vascularity of its walls, which follows from chronic inflammation, limits bone-cell proliferation. Sargent quotes a case in a man, age 50, who had been under observation for sixteen years. The cavity was originally 4 inches in length, and at the end of the sixteen years was still 3 inches long. That new bone will not form in cases of sclerosis of the ends of the bones is shown in many cases of non-union of fractures. In healthy bone there is no difficulty in replacing artificially removed osseous tissue. Bancroft, having excavated holes in the humerus of dogs, and allowed the cavity to fill up with blood-clot, found that four months later this blood-clot was completely replaced by bone. Fortunatcly, this is not essential for a good functional result in man.

NOTES OF CASES.

Case 1.—F. H. W. W. Gunshot wound of the upper end of humerus ; tunnel type. Wound discharging 4 years 8 months. Filled by a flap from the anterior part of the deltoid muscle. Healed in 18 days.

Case 2.—W. J. S. Gunshot wound of the upper end of humerus, with bony ankylosis of shoulder-joint ; tunnel type. Discharging 2 years 2 months. A flap taken from posterior part of the deltoid, as the anterior portion was absent. Did not heal. At a second operation a previously overlooked sequestrum was removed.

Case 3.—A. C. R. Gunshot wound of the middle of the humerus; gutter type. Discharging 2 years 1 month. Flap from the inner head of the triceps. Failure.

Case 4.—S. H. E. Gunshot wound of the upper end of radius and ulna; cavity between the lower fragment of the ulna, and the bony bridge joining radius and ulna. Flap from the extensor carpi ulnaris. Sinus, which had been discharging 2 years 2 months, healed in 33 days.

Case 5.—H. U. N. Gunshot wound of the ilium near the sacro-iliac joint. Discharging 2 years 2 months. A muscle-flap from gluteus maximus. Healed in 49 days.

Case 6.—W. M. Gunshot wound of the upper third of the femur. Discharging 4 years 7 months. A muscle-flap from vastus externus. Failure.

Case 7.—A. J. H. Gunshot wound of the lower third of femur. Large cavity. Discharging 2 years 1 month. A double flap of semimembranosus and vastus internus, with their bases above, was used. Healed in 74 days. A bacterial count showed 2 staphylococci per field, at the time of operation.

Case 8.—C. G. S. Gunshot wound of the middle of femur. Discharging 1 year 8 months. A muscle-flap from vastus externus. Healed in 14 days. A subsequent abscess caused by a piece of bone left behind at operation: this was removed. Wound then healed soundly.

Case 9.—W. G. M. B. Gunshot wound of the lower third of the femur. Discharging 4 years 5 months. Flap cut from biceps, as quadriceps was chiefly fibrous tissue at this level. Healed in 49 days.

Case 10.—S. A. U. Gunshot wound of the middle of femur. A large ivory peg had been inserted 9 months later; the wound did not heal, and had been discharging 2 years 3 months. Sound union of femur. Sinus led down to a large peg, which was removed and the cavity filled by a double flap from the vastus externus. Healed in 33 days.

Case 11.—W. W. Gunshot wound of the lower third of the femur. Discharging 1 year 5 months. Sequestrectomy. Cavity filled by a biceps-flap. Healed by first intention.

Case 12.—B. U. R. Gunshot wound of the middle of the femur. Discharging 1 year 6 months. Cavity multilocular. A muscle-flap cut from vastus externus. Healed in 28 days.

Case 13.—T. A. Y. Gunshot wound of the lower third of the femur. A large multilocular cavity. Discharging 1 year 8 months. Cavity filled by semimembranosus muscle. Healed in 79 days.

Case 14.—P. E. D. Gunshot wound of the middle of the femur; tunnel type. Discharging 3 years. A muscle-flap from vastus externus. Healed in 21 days.

Case 15.—H. S. J. R. Gunshot wound of the middle of the femur. Discharging 3 years 9 months. A flap from vastus externus. Healed in 90 days.

Case 16.—R. C. Gunshot wound of the lower third of the femur. Discharging 3 years 1 month. Albuminuria present. Cavity filled up by a flap from the biceps. Healed in 34 days. Albumin in urine disappeared.

Case 17.—O. R. Gunshot wound of the middle of the femur. Sinus discharging 4 years 6 months. Patient had been operated on fourteen times before admission. Operation in two stages, because of much pus present in cavity. A flap from the vastus externus inserted at second stage. Wound has not healed.

Case 18.—A. K. Gunshot wound of the lower third of the femur. Discharging 4 years 3 months; gutter type. A flap cut from the quadriceps. Healed in 50 days.

Case 19.—H. A. R. Gunshot wound of the upper third of the femur. Discharging 2 years 1 month. A flap from the vastus externus, with its neck above. Healed in 50 days.

Case 20.—C. T. F. Gunshot wound of the lower third of the femur. Discharging 4 years 3 months. Cavity filled by the sartorius. Healed by first intention.

Case 21.—J. W. D. Gunshot wound of the head of the tibia. Discharging 1 year 9 months. A long flap was taken from the inner head of the gastrocnemius, and this had to be introduced into the cavity through the inner wall of the tibia. Healed in 56 days.

Case 22.—G. H. C. Gunshot wound of the head of the tibia. Discharging 6 years 10 months. A flap cut from the inner head of the gastrocnemius. Sloughing of the part of skin followed its undermining. Healed in 42 days.

Case 23.—S. T. O. Gunshot wound of the head of the tibia. Discharging 4 years 1 month. A large ulcer was present; ulcer excised. The bone cavity was filled by a flap from the inner head of the gastrocnemius. Skin closed by a pedicled skin-flap, turned down from the lower third of the thigh. Healed in 28 days.

Case 24.—B. B. Gunshot wound of the head of the tibia. Discharging 3 years 4 months. A flap from the inner head of the gastrocnemius. Healed in 56 days.

I am indebted to Mr. E. W. Hey Groves for his help, and for many suggestions in this work; and also to Miss D. Pillers for the drawings.

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VISITS TO SURGICAL CLINICS AT HOME AND ABROAD.

SIR WILLIAM THORBURN'S CLINIC AT MANCHESTER.

In 1909 the new hospital was opened in Manchester. This magnificent building, which should be seen by all, and especially by those interested in the planning of an up-to-date hospital, was the outcome of much thought and labour devoted by Sir William Thorburn. It was he who conceived and effected the principle of the establishment of complete surgical in-patient units. Thus, in one block of buildings and on the same floor one finds wards for male and female patients, each ward having its own separate rooms

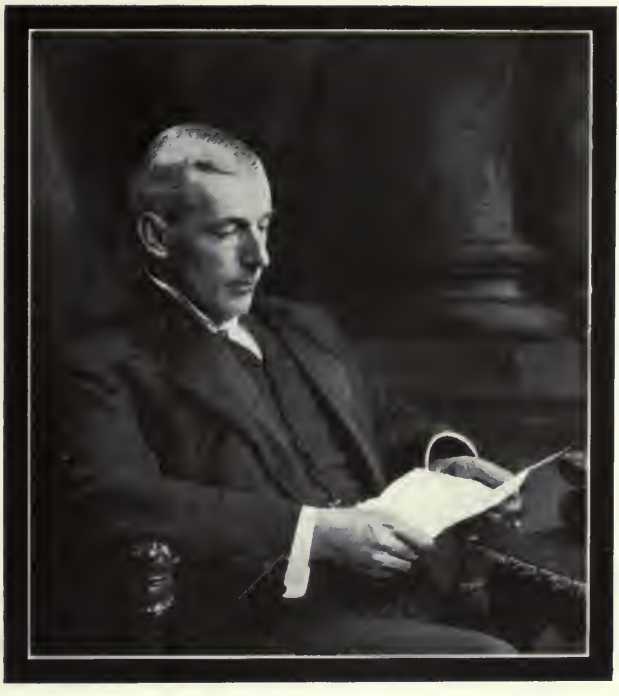

Fig. 336.—Sir William Thorburn, K.B.E., C.B., C.M.G.

for the isolation of cases; a theatre block consisting of the surgeon's room, where records are kept, a room for the administration of the anæsthetic leading into the theatre, which connects with a large sterilizing annexe; and a recovery room used, if required, for resuscitation purposes.

There are five such surgical units, and, although in some cases units are on different floors above each other, by a clever architectural device the theatres have been provided with proper illumination by means of a top light in each case. It must be a great satisfaction to Sir William Thorburn, when looking back on those days of arduous toil in which

this hospital was planned and built after his own design, to see now the smooth working of the hospital which his forethought has rendered possible.

In another part of the building are the premises set aside for the School, including—as well as common-rooms, library, class-rooms and laboratories—a fine lecture theatre.

Professor in Surgery to the University, Sir William Thorburn has given in this theatre many lectures and demonstrations; and, though now he has formally retired from the active staff of the hospital, he has acceded to the request of his colleagues to give from time to time a course of lectures on some selected subject. His teaching in clinical surgery is of an attractive type: he faces the problem from the students' point of view, and, by analyzing the subject and presenting each member of his audience with a 'schematized' chart at the beginning of each lecture, he creates and maintains an interest. It is characteristic that he will not draw pictures, but he will, and invariably does, build up diagrams easily visualized, and bearing only essential features.

On the writer's introduction to the clinic, he was fortunate enough to find the unit engaged in the operating theatre, and a description of the morning's work will serve to indicate the general arrangements and technique. The first case was brought to the anæsthetizing room in bed, by means of a trolley (*Fig.* 337), which is first wheeled into position under the bed, its framework then being elevated by a simple movement of a lever which raises the bed from the floor. The use of these trolleys, which were seen by Sir William Thorburn in Stockholm and brought to this country, has many advantages over the method of moving a patient by transference to a wheeled stretcher: a minimum of lifting is effected before and after operation; a patient is settled comfortably in bed directly after an operation, the operating table being wheeled into the anæsthetizing room where the bed has been kept, and a single lifting from the table to bed is the only disturbance to which the patient is subjected. In the anæsthetizing room the patient was transferred to the operating table and placed, prior to the induction of anæsthesia, in the position to be maintained during the operation.

FIG. 337.—Bed trolley.

Here one had the pleasure of meeting Sir William Thorburn's friend and colleague, Mr. Wilson, who for many years has been the anæsthetist to the clinic. One appreciated the advantages under which these two men worked, each devoting his attention to the task in front of him, yet ever mindful of the other. This close association of two old friends in their respective branches of surgery must on many difficult and tiring occasions have lightened their burden and added to the efficiency of their work.

Case 1.—Operation for injury to the brachial plexus involving the upper trunk—right side.

Six months before operation the patient sustained an injury to his right shoulder, being pitched from a motor-bicycle. As a result he developed, without signs of fracture or dislocation, a paralysis of certain muscles of the upper limb, namely, supraspinatus, infraspinatus, deltoid, and biceps; there was no paralysis of the rhomboid muscles. A curved incision, crossing the lower part of the posterior triangle of the neck, was made, the incision being first outlined and cross-marked with the point of a cutting needle. After division of the platysma a considerable mass of scar tissue was encountered. A careful

dissection was made, exposing the upper trunk of the brachial plexus, which was found to be bulbous at the junction of the 5th and 6th cervical nerves. Further dissection freed the trunk with its bulb from the surrounding scar tissue, which was extremely dense. The bulb itself was dissected, and there was found embedded in its substance a shell of bone, sufficient in size to enclose the original nerve-trunk on its front and lateral aspects. This piece of bone, which, after removal, had all the appearances of having come from the posterior aspect of the clavicle, was dissected out with its enclosing scar tissue, and a groove in the nerve where this foreign body had lain was evident. After its removal, however, the whole nerve-trunk became more mobile and normal in appearance, the groove becoming gradually obliterated. It was therefore decided not to resect any portion of the nerve, and the wound was closed in layers with catgut sutures, finishing with a fine continuous suture of horse-hair (to be removed on the following day).

Case 2.—Operation for causalgia, the result of an old gunshot wound of the axilla involving the brachial nerves—left side. This patient had suffered from intense pain in the hand and forearm since being wounded in the early days of the war. The hand and arm were useless from contractures following injury to the median and ulnar nerves. Two operations upon the nerves themselves had proved unsuccessful.

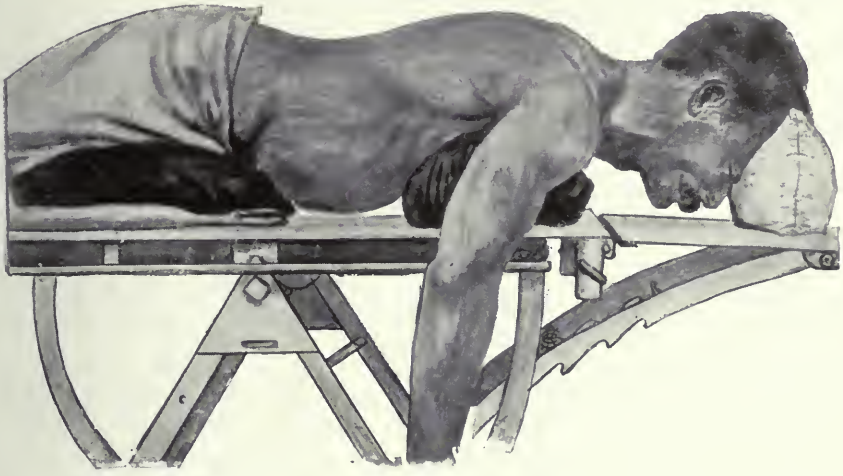

FIG. 338.—Position of patient for laminectomy.

The patient was in the prone position (*Fig.* 003) (I had previously found Mr. Wilson himself testing the comfort of the position in which this patient was to lie). A vertical incision in the middle line was made over the spinous processes of the lower cervical and upper thoracic vertebræ, the spinous processes were cleared on each side, the interspinous ligament between the lowest two exposed spines was divided, and the processes were severed from the laminæ. These processes, still attached to each other and above to the remaining spinous processes, were folded upwards (to be subsequently replaced). The laminæ were then cleared and, with a laminectomy saw, divided on each side and removed. The dura mater was cleared and opened, being held open by means of retracting sutures passed through the cut edges.

The posterior roots of the 6th, 7th, and 8th cervical and 1st thoracic nerves were then identified, isolated, and divided close to their attachment to the cord.

The dural opening was closed with a continuous catgut suture, and a layer of the deeper muscles was joined over the dura by means of interrupted catgut sutures. The spinous processes were replaced to lie on this deep layer of muscle. The more superficial muscles were then united over the spinous processes, sutures being passed so as to retain the processes in position. Finally, the skin was closed with interrupted salmon-gut sutures.

Although the patient was a stout and muscular man, bleeding was readily controlled by occasional pressure and packing.

The various stages of the operations and the practical points arising out of them were explained, as the operation proceeded, for the benefit of the students present. Nor did the interest flag in the short interval between the operations, during which the students were regaled with instructive and amusing anecdotes.

In the theatre technique, the theatre sister plays a prominent part: to her is entrusted the management of the instruments, sutures, swabs, and dressings; but although this all-important function rests with the sister, it is the practice to train all dressers of the unit in that work. The principal assistant at the operation is the house surgeon, with a dresser as an additional assistant. The principles of aseptic technique

FIG. 339.—New Hospital, Manchester.

are conscientiously adhered to, and, as a detail of dress, the spectacle-frame type of mask is worn, from which is hung a wide piece of stout gauze.

Among the cases seen in the wards, the following are of exceptional interest:—

Two cases of intrathecal spinal tumour in the upper and lower thoracic regions respectively: in each case laminectomy with removal of the tumour had been performed. These patients were in perfect condition, and had no incapacity whatsoever from their laminectomy. The spinous processes had been left *in situ* as in the operation described above; further, they had both made remarkable recoveries with regard to their spinal lesions.

A case of locomotor ataxy with gastric crises: in which laminectomy, with division of the posterior roots of the 6th to 11th thoracic nerves, had been performed some years ago, with complete relief of pain.

Two cases of trigeminal neuralgia : in which the Gasserian ganglion had been removed, with complete cure. Both these patients, though one is over 60 years of age, are now doing a full day's hard work.

A case in which subtemporal decompression on the left side had been performed for an unlocalized cerebral tumour.

A case of Jacksonian epilepsy : in which a left-sided tumour in the Rolandic area had been removed. Some temporary aphasia and right hemiplegia had followed the operation, but soon cleared up, and the patient made a complete recovery. In this case a bone-flap was cut and replaced.

A case of double cervical ribs, both of which had been removed, followed by complete relief of symptoms.

FIG. 340.—Group of members of the clinic.

The writer's thanks here are due to Sister Gordon, sister in charge of the ward for female patients, for the trouble she took to collect the cases for inspection and for the facilities she provided for their examination. One was privileged to observe again that bond of friendship and devotion between sister and surgeon, strengthened by many years of strenuous work, and directed towards one common object, the comfort and well-being of their patients.

It happens that the cases mentioned in this account belong to the field of neurological surgery in which Sir William Thorburn has done so much pioneer work. It was his investigations which established the details of the segmental distribution of the spinal cord in man ; but it is to be remembered that he has not allowed this branch of surgery to restrict his researches and progress in other more general lines of surgery, as his teaching and writings on various topics have shown.

A CASE OF PERSISTENT VITELLINE ARTERY: FATAL INTRA-ABDOMINAL HÆMORRHAGE FROM RUPTURE OF THE VESSEL.

By JOHN FRASER and J. E. McCARTNEY, Edinburgh.

We believe that for several reasons there is sufficient justification to warrant the publication of the following case. The condition is one of considerable rarity, as is borne out by the fact that there are so few recorded examples in the literature. It is of interest from a developmental point of view. The reason, however, which really influenced us in publishing the case has been a clinical one: it illustrates a danger which previously we had not recognized, and it demonstrates how very narrow may be the margin between success and failure in what appears to be the simplest type of case.

FIG. 341.—The appearance of the condition as revealed at post-mortem examination. A, Portion of anterior abdominal wall; B, Persistent vitelline artery; C, Sub-peritoneal hæmorrhage.

Baby J. W. Age 4 months. Admitted Sept. 18, 1920.

History.—The baby was brought to hospital by the parents on account of a small tumour at the umbilicus. Attention was drawn to the tumour, not on account of its size, which was no greater than that of a pea, but because there was a persistent irritating discharge from its surface, which tended to produce excoriation of the surrounding skin.

On Examination. — The child was apparently healthy. At the umbilicus, and slightly buried within its folds, there was a small tumour the size of a pea, composed, one would say, of granulation tissue, and growing by a narrow pedicle from the deeper portion of the umbilicus. Its surface gave rise to a small amount of secretion. There was no sign of any cavity in its interior, and it did not appear to connect with any deeper abdominal structure. The condition was regarded as that of a simple umbilical granulation.

Subsequent History. — These conditions have always been treated upon the simple lines of touching the pedicle with the actual cautery, and this treatment was adopted in the case under review. The tumour was lifted from the umbilicus, and the pedicle was divided with the cautery. The condition was looked upon as entirely a minor one, but, as the child was a country case, it was admitted for a few days to the hospital wards. As events turned out, this was a fortunate occurrence. The child remained well for twenty-four hours, but after this period it began to show certain alarming features. The first intimation of anything wrong was several attacks of sickness. Gradually it became quite clear that the child was gravely ill. The pulse increased in

rapidity, and the appearance was one of considerable shock. It was very difficult to ascertain the origin of these alarming symptoms. There was no sign of any peritonitis. There was no obstruction; the bowel had moved in connection with the administration of rectal salines; and, to be correct, no actual diagnosis was come to beyond one of delayed shock. Unfortunately, the child succumbed within forty-eight hours of the original operation. The explanation is detailed in the following facts.

Post-mortem Examination. (*Fig.* 341).—On opening the abdomen, the peritoneal cavity was seen to contain a large quantity of blood, of which about four ounces were in the pouch of Douglas. There was no evidence of peritonitis or of perforation. A thin fibrous cord, one and a half inches long, stretched from the umbilicus a little to the left of the middle line, to the mesentery of the ileum, about eighteen inches from the ileocæcal valve. The actual attachment of this cord to the mesentery, which appeared to be half an inch from the gut wall, was hidden by a hæmatoma in the mesentery. This hæmatoma was about an inch in diameter, and at the apex was a small hole from which the blood had escaped into the peritoneal cavity. The other organs of the body showed nothing worthy of note.

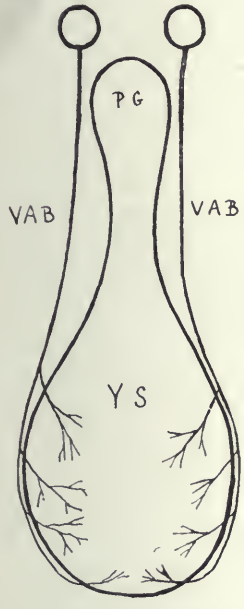

FIG. 342.—Primitive gut and yolk sac with the two ventral aortic branches ramifying *on* wall of yolk sac.

On dissecting the cord through the hæmatoma, it was found to be attached to a branch of the superior mesenteric artery. This shows that the cord was the persistent left vitelline artery. Its lumen was completely obliterated, even at the junction with the superior mesenteric branch. Opposite the attachment of the vitelline artery there arose from the superior mesenteric artery a small branch which had been torn across, and this was responsible for the hæmorrhage.

During the operation, on lifting the tumour from the umbilicus, traction was exerted on the vitelline artery and, through it, on the main vessel, thus causing the rupture of the small branch. As a result, a hæmatoma was formed in the mesentery, and after this had attained a certain size, the stretched peritoneum over it ruptured, and blood escaped into the peritoneal cavity.

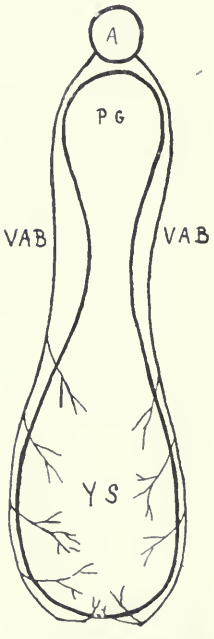

FIG. 343.—A later stage than *Fig.* 342. The two vitelline arteries taking origin from aorta.

It is interesting to consider briefly the development of this condition. In the embryo, the vitelline arteries arise as two ventral aortic branches, which ramify in the wall of the yolk sac (*Figs.* 342, 343). These vessels then fuse to form a short common trunk, which later becomes the superior mesenteric artery. One of the ventral aortic branches persists as the definite vitelline artery, and proceeds round the gut wall along the vitelline duct to the yolk sac (*Fig.* 344). Later, when the intestines are entirely within the abdomen, the vitelline duct ceases to exist, and the vitelline artery is stretched to a filamentous strand, so that it normally ruptures and disappears. In this case, however, the artery had persisted, and the tension caused it to be pulled away from the gut wall, so that the artery emerged from the peritoneum at its junction with the superior mesenteric artery without being adherent in any way to the wall of the bowel.

Fig. 345 shows diagrammatically the anatomical relations in the present case. The fibrous cord must have been under tension at the time of the operation, as the small amount of pull on the tumour was sufficient to rupture the small branch at the junction.

Discussion.—No similar case has been found in the literature. The occasional persistence of vitelline arteries was known to Meckel, who says "that in man as well as in animals, the remains of the vitelline canal disappear earlier from the intestine than from the vascular systems". He also quotes a case where, in a child of three months, he found a persistent vitelline artery arising from the superior mesenteric artery, and proceeding along the entire length of a Meckel's diverticulum, and which was "converted at its end into a solid thread several inches long, and hanging free."

Spangenburg found in a young man twenty years of age a persistent vitelline vein, which was patent from the mesenteric vessel for half its length.

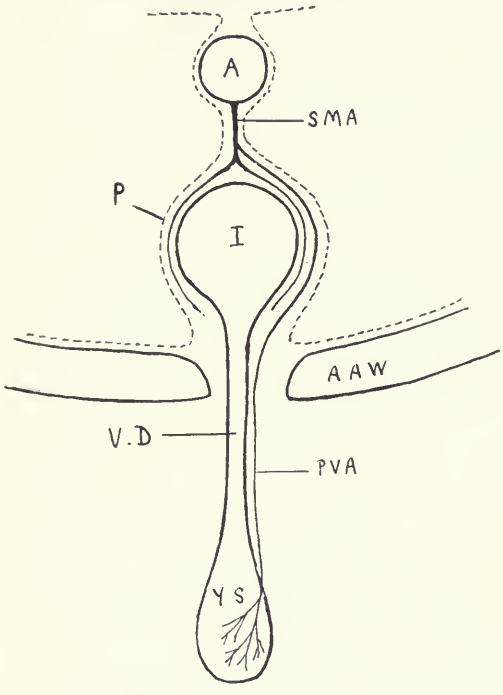

FIG. 344.—The two vitelline arteries have fused to form the superior mesenteric artery (S.M.A.). The right artery below the junction has disappeared, the left (P.V.A.) runs along the vitelline duct to the yolk sac. At this stage it is close to the gut wall, and under the peritoneum.

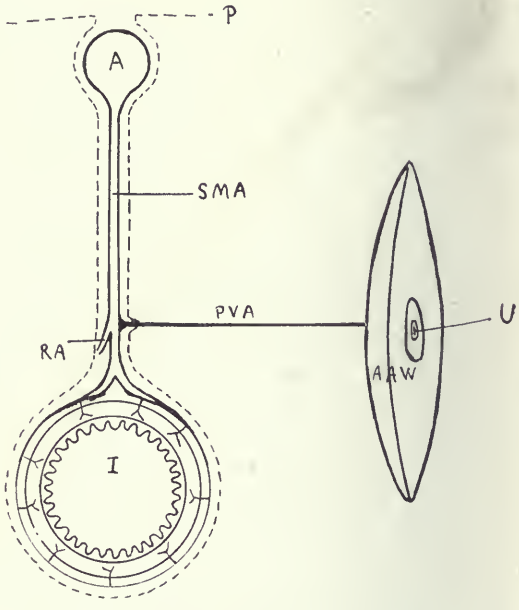

FIG. 345.—The condition existing in the described case. The relation of the peritoneum is shown by the dotted line. The persistent artery (P.V.A.) is connected with the anterior abdominal wall and with the superior mesenteric artery. The small ruptured branch is shown at R.A.

Eschriet records a fatal case of strangulation of the bowel in an old woman, due to a persistent omphalo-mesenteric vessel. The importance of these persistent vessels in causing strangulation has been emphasized by Falk, Schroeder, and Leichtenstein, who quote cases.

A comprehensive account of persistent omphalo-mesenteric remains is given by Fitz,[1] from whom the above references are quoted.

Our thanks are due to Professor Arthur Robinson for assistance in connection with the developmental aspects of the case.

REFERENCE.

[1] FITZ, *Amer. Med. Journal*, 1884, lxxxviii, 30.

CAPILLARY ANGEIOMATOSIS OF THE PAROTID GLAND (PARTIAL EXCISION).

By CLEMENT NICORY, London.

WITH A PATHOLOGICAL ACCOUNT AND REMARKS

By Professor S. G. SHATTOCK, F.R.S.

The condition to be described is of interest from both a clinical and a pathological point of view. The patient, a male infant, age 9 months, was seen by me as an out-patient at the Evelina Hospital, London. The child was of normal development, and had given no difficulty since birth. When it was six weeks old the mother accidentally noticed a round lump, about the size of a marble, in the right parotid region. The swelling was said to have gradually increased, and when seen there was a marked prominence on the right side of the face, about the size of a bantam's egg, corresponding anatomically with the parotid gland. The skin over its most prominent part showed a slight bluish-red tint produced by a few small superficial vessels. There were no signs of inflammation, and the skin was freely movable over the elevation. On palpation the tumour felt uniformly soft and elastic, but without definite fluctuation. It was not movable on the deep structures, and yielded no pulsation.

From within the mouth the tumour gave a similar impression. The opening of Stenson's duct appeared normal; no fluid was seen to exude on applying firm pressure to the mass. There was no history of constitutional disturbance, or pain; and the child seemed very little concerned during examination. The neighbouring lymphatic glands were not enlarged, and there was no pyrexia.

The diagnosis was, a tumour in connection with the parotid gland. The mother was anxious that something should be done to reduce the increasing disfigurement. The patient was admitted under Mr. H. S. Clogg, by whose kind permission I am able to publish the following account of the operation.

A slightly curved incision with its concavity upwards, 3 inches in length, was made from just behind the lobule of the right ear, half an inch above and almost parallel with the lower border of the mandible. On reflecting the skin, a non-adherent bluish mass of nævoid appearance was exposed, though separable only with difficulty from the deeper structures. The external carotid artery was seen entering the lower part of the tumour; and only after clamping it and securing numerous bleeding points was hæmostasis obtained. The whole of the parotid gland appeared to be involved, and part of the retro-mandibular portion had to be left owing to its proximity to the large vessels. Stenson's duct and branches of the facial nerve were unavoidably divided. The incision healed by first intention; the child made good progress, though when discharged the affected side was still slightly larger than the left, and the facial paralysis produced at the operation was still present. The nævoid condition of the skin which was noticed on admission had disappeared. Whether the origin of the angeioma is to be associated with the incipient function of the gland, it is impossible to determine.

In the case of the parotid the ptyalogenous function is present in the new-born child; in that of the submaxillary, ptyalin secretion is not established under the age of two months.[1] The mucinogenous function of the latter gland is probably later.

Since the observations cited by Halliburton, further investigations have been carried out in the same direction, with the following additional results: (1) The secretion of ptyalin before term. Moll[2] obtained saliva containing ptyalin from a parotid fistula in

a child prematurely born at 7 months. (2) The increased output of ptyalin after starch feeding. Finzi[3] found the amylolytic power was the same up to the age of six months, whether the food contained starch or not; after six months the power was increased if the food contained starch; the property was, moreover, highest at midday.

The following results have been recently obtained by myself at the Evelina Hospital, London. The saliva was collected by giving infants plugs of gauze (weighing 500 mgrms.) to suck, the amount of the saliva being estimated by the increase in weight of the plugs. The latter were extracted with distilled water, and the action of the fluid tested on starch solution. Ptyalin was found present shortly after birth in the saliva of infants prematurely born at 32, 34, and 36 weeks. The quantity of the ferment was very small; but it gradually increased during the first year; after this no appreciable change was demonstrable. In the premature infant of 34 weeks, 1 part of the ptyalin extract took 98 minutes to reduce an equal part of 1 per cent starch solution to the achromic point; whereas at full term (40 weeks) it took only 23 minutes; three months after birth, 11 minutes; and eight months after birth, 1 minute. The action was more pronounced in strong infants than in weak. After the age of 4 months the saliva of children who had received starch in their diet contained more ptyalin than that of those who were having none.

PATHOLOGICAL NOTE AND REMARKS BY PROFESSOR S. G. SHATTOCK.

Figure 346.—To the eye the portion removed exhibited the familiar structure of a salivary gland, the lobules being quite discrete, and but loosely held together by connective tissue.

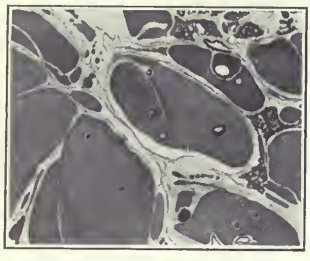

FIG. 346.—A section of the angeiomatous parotid gland described, enlarged about six times, showing the persistence of its normal lobulated construction.

Figure 347.—A microscopic study yields the following results: With few exceptions the proper glandular structure of each lobule is replaced by a close network of capillaries. In all the lobules affected, one or more patulous ducts, with their typical columnar-celled lining, are distributed in the capillary basis; in some there are, in addition, small groups of the secreting cells, these different elements being widely disparted in the vascular neoplasm; the stages from partial to complete replacement are readily traceable. Small, ill-defined groups of lymphocytes lie here and there between the capillaries; these correspond in position with the gland-ducts and cells of the alveoli. The interlobular connective tissue presents no angeiomatous abnormality. The capillaries composing the mass which replaces the lobules are so tortuous and compressed that they can scarcely be traced in detail, except by the partial persistence of the lumina, or the narrow lines of red cells within them. As studied in favourable spots the vessels, where patulous, consist of a single layer of endothelium, and they lie in apposition; where broader, the intervals contain a few connective cells, with accompanying fibrillæ.

Remarkable and little known as the condition is, it is not unique. There is in the Royal College of Surgeons, London, a circumscribed angeioma of similar kind, and in the same position, thus described in the recent Catalogue of General Pathology.[4]

A circumscribed angeioma, 5 cm. (2 in.) in chief diameter, from the parotid region of an infant. It has a definitely lobulated construction, and to the naked eye closely resembles the proper salivary gland, in the lobules of which it has arisen. Microscopic examination shows that each lobule of the gland is replaced by a plexus of capillaries with a minimum of intervening tissue. In each there are widely-scattered remnants of the proper glandular elements.

To these may be added a third example of intrasalivary angeioma, but in this instance involving the submaxillary, and not the parotid, gland. The history of this case,

which was under the care of Mr. Raymond Johnson, and operated upon by Mr. G. E. O. Williams in 1911 (to both of whom we are indebted for leave to publish it) is as follows :—

The patient, a child, age 4 months, presented a rapidly-enlarging swelling in the neck ; on examination it was found to be a fairly-well circumscribed tumour, the size of a Tangerine orange, below the left angle of the lower jaw. After excision it was thought to be a nævoid lipoma ; it was of dark-purple colour, and without a definite capsule. Many tortuous and dilated vessels were distributed through its substance. In microscopic structure I find this specimen to be a perfect replica of the two just described, the lobules of the gland being equally discrete. A few of the latter are normal ; in some, the

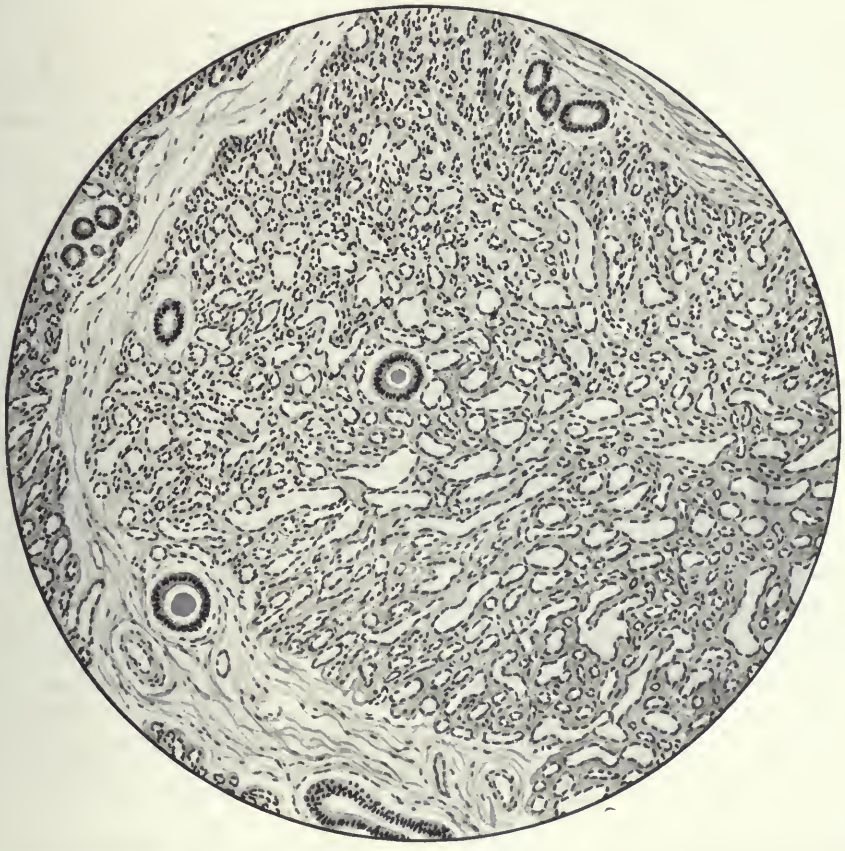

FIG. 347.—Showing a single lobule of the angeiomatous gland. It is completely pervaded with a close plexus of capillaries, in the midst of which lie some of the ducts. The septa are uninvolved in the angeiomatosis. ($\frac{2}{3}$ obj.)

angeiomatous element involves only part of a lobule ; in others, the whole, the volume of these being much augmented. The ducts and groups of secreting cells are dispersed amid the vascular plexus, as they are in the other two examples. The vessels themselves are simple capillaries with mere traces of intervening tissue. In certain spots the tortuous, thin-walled channels are abnormally wide or ectatic, though still capillary in structure. The interlobular septa are intact.

Lymphocytic foci are much less pronounced than in the first of the cases referred to.

In regard to all these examples of salivary angeiomatosis, it may be observed that the general histogenesis is of the same kind as that traceable in the development of a

capillary angeioma of the subcutaneous fat, where the lobulation and circumscription of the neoplasm may be as pronounced as is that of the lobules of the fat in which it arises. In the museum of the Royal College of Surgeons there are contained the two following specimens :—

1425.1. (*General Pathology*).—A lobulated angeioma which was removed from the shoulder of an infant. The growth is of flattened oval form, 3·8 cm. (1½ in.) in chief diameter, and is composed of a series of closely apposed but discrete lobules. Microscopic examination shows it to consist of a close network of capillaries with a minimal amount of intervening connective tissue. Scattered through the lobules there are small groups of unilocular fat-cells, the marked lobulation of the tumour being explained by its having arisen in the lobules of the subcutaneous tissue.

1426.1. (*General Pathology*).—A flattened oval angeioma, which was removed from under the skin over the breast of a child 9 months old. A small portion of the skin which was involved in the tumour and discoloured during life, has been removed with it. The growth is distinctly circumscribed, and lobulated in construction. Bristles have been put unto certain of the larger vessels which lie in the interlobular connective-tissue. Histologically, the lobules consist of a plexus of capillaries, in the midst of which fat-cells occur in varying numbers. In the case of some lobules the structure consists almost solely of adipose tissue, proving that the lobulation of the tumour is due to the origin of the angeioma in the original fat of the part.

The recognition of this origin of subcutaneous nævi in the lobules of the subcutaneous fat dates from the time of Virchow, and is concisely described in the incomparable *Krankhaften Geschwülste* (Angeioma). He observes : " The subcutaneous nævus presents most frequently the form of a tumour, and this is sufficiently well limited, though not surrounded with a special capsule. In general the aspect of this form depends on the mother tissue from which it proceeds ; and as the fatty subcutaneous tissue presents as a rule a lobulated disposition, so the nævus also takes a kind of lobulated structure."

Historically, the first example of salivary angeioma recorded in this country is that by Gascoyen.[5] The patient was a man, age 44. The tumour was congenital, and latterly had come to occupy the whole of the parotid region. There was no pulsation or bruit in the mass, which became tense and livid under excitement. Other nævi were scattered over the body and limbs. After death (which occurred from suffocation) several nævi were found studding the surface of the intestines ; one of these originated in the submucosa. The parotid tumour consisted of tortuous and dilated blood-vessels embedded in the gland, the structure of which was plainly seen filling up the intervals between their ramifications. The vessels " appeared to be the capillary veins of the gland enormously distended, which opened into large pouches, many of the dilatations being filled with phleboliths, some as large as a horse bean." Of this specimen no histological examination was made, and finer details are altogether wanting.

Two further instances are referred to by Virchow[6] as having been possibly parotid angeiomata.

One of the patients was a woman, age 29. The angeioma, which involved the parotid region, was chiefly if not solely of the arterial kind, the vessels being fed from the temporal artery. An attempted operation was followed by such hæmorrhage that no excision was carried out ; and no detailed information as to the anatomical lesion of the parotid gland is forthcoming.

The other case was a boy, age 8, who presented a swelling of the parotid and adjoining area ; the tumour projected into the mouth in the neighbourhood of Stenson's duct. It had been noticed only for a year, and from its rapid growth and uneven surface it was regarded as malignant in character. After preliminary ligation of the common carotid it became considerably paler ; during its removal the distended condition of the numerous and enlarged offsets of the carotid excited surprise. No details regarding the condition of the parotid gland are recorded.

There is at present attending St. Thomas's Hospital a further case of angeioma, implicating the right parotid region ; but as the condition is being treated by means of

radium, exact pathological details are as wanting in this as in the three last referred to. The patient was admitted under Mr. Corner in December, 1920, with a large nævoid swelling affecting the mucosa of the right cheek, extending forwards as far as the angle of the mouth, and posteriorly surrounding the orifice of Stenson's duct. The tumour, which had been slowly increasing since birth, bulged between the dental arches, and externally led to a protrusion on the right side of the face from the ear to the mouth. The suprajacent skin was uninvolved.

Two tubes of radium were inserted into the swelling—for 7½ hours on Dec. 12, and for 10 hours on Dec. 18—but with little result. Two phleboliths about the size of peas were subsequently felt in the mass, the formation of which was thought to have followed the insertion of the radium tubes.

Figure 348.—On tracing the history of the case, it was discovered that the patient had previously been admitted when two years of age, under Mr. H. H. Clutton, with the note that he had been born with a nævus in the cheek, which had been increasing. At the date of admission in March, 1904, there was a large, somewhat compressible, swelling on the inside of the cheek; the diagnosis was, "Cavernous angeioma of the cheek". No operation was carried out.

FIG. 348.—A photograph of the last case referred to, of angeioma involving the right parotid region and extending thence to the cheek and lips.

The early age at which the disease was noticed in each of the three cases which were fully examined microscopically, may be finally pointed out: (1) Parotid, 6 weeks; (2) Parotid, infant; (3) Submaxillary, 4 weeks; but, as already remarked, whether the origin of the angeiomatosis is in any way related to the nascent function of the gland is a problem beyond determination. In Gascoyen's case (male, age 44) the disease was congenital. And the same is true of that at present attending St. Thomas's Hospital (male, age 18).

The gross enlargement of the veins in both of these seems to indicate that, with the lapse of time, a primary capillary angeiomatosis of the gland is succeeded by an increase in the size of the afferent and efferent vessels; a result which might be anticipated in view of the increasing demand for blood entailed by the growth of so vast a capillary plexus in the glandular substance.

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[5] GASCOYEN, *Path. Soc. Trans. Lond.*, 1860, xi, 237.
[6] VIRCHOW, *Canstatt's Jahresbericht*, 1889, iv, 312.

BABCOCK'S EXTRACTION OPERATION FOR VARICOSE VEINS.

By G. H. COLT, Aberdeen.

This paper deals with the late results in twenty cases of Babcock's extraction operation for varicose veins. The cases traced are from the 60 patients that I operated on in the 1st Scottish General Hospital before August, 1916, and I am indebted to the Officer Commanding for his permission to quote them.

The patients were recruits or old soldiers who had had varicose veins and in whom training had produced symptoms. Of the sixty, the oldest was 49, the youngest 18, and the median 28 years of age. The longest duration of symptoms noted was eighteen years, the shortest three weeks, and the median three years. In 11 cases there had been no symptoms, but the condition of varix had been noted on examination: in some of these there was marked tortuosity. The right side alone was affected in 5 cases, the left side alone in 12, and both in 43 cases. Operation was performed on 103 limbs ($43 \times 2 + 5 + 12 = 103$). Counting 2 ft. 3 in. as the length of vein extracted in each limb, the quantity is nearly seventy-eight yards.

Stated dogmatically, Babcock's extraction is the operation of choice for most cases, especially for the early ones in which the internal saphenous system is involved. It was introduced into this country early in 1908 by Sir H. M. W. Gray, who published papers on it in 1909[1], in which he gives a résumé of its history and the indications and contra-indications for its performance. He mentions a difficulty which is sometimes experienced in getting the knob of the instrument to pass a valve in the lower third of the thigh. This was often noted in these cases, and I find that there is generally a small tributary there communicating with the deep veins and situated four inches above the patella. The branch, as seen on the extractor, is half an inch long and comes off at right-angles to the main trunk. It is probably one of several which may unite the saphena to the deep veins in the thigh. There has been no opportunity of finding out in which direction the blood normally flows in it. When varicosity is present the blood flows *from* it and refills the internal saphena vein. It may be remembered that Thelwall Thomas in 1896,[2] after three years' trial, advised transferring the site of Trendelenburg's operation from the lower third of the thigh, which is the position originally recommended, to near the saphenous opening, and presumably the presence of this branch and of other communicating branches is responsible for the failure of simple excision of part of the internal saphena in the thigh to interrupt completely the superficial circulation there. Newbolt[3] mentioned a case in 1911 in which Trendelenburg's operation promised to be very successful, and was so for four years, but after that time the varicosities returned in greater degree than ever. The procedure, however, is of undoubted value when an impulse is present.

Sir Henry Gray[1] modified the original instrument as described by Babcock in 1907[4] by varying the size of the acorn bulbs and by putting a joint in the middle of the shaft for ease in sterilization and convenience in use when only short lengths of vein are being extracted. Babcock[5] also, in 1910, made the shaft side of the acorn cup-shaped so as to catch up the vein better and prevent its inversion and slipping over the end of the instrument. Tamisea[6] described an improvised extractor made from patella wire and the base of a cartridge with which he removed the internal or external saphena vein and tributaries at a base hospital in France. The patients were sent back to the front in from ten to fourteen days. The late results of these cases would be valuable, as apparently no additional operation on the tributaries or other veins was performed. As sold to-day

the probe portion of the instrument is of steel wire which greatly aids its passage should slight force have to be used to pass valves or extend tortuosities. The acorn tips are gauged to—

No. 1.—No.	10	English scale	=	No.	19	French scale.		
„ 2.— „	13½	„	„	= „	24	„	„	
„ 3.— „	16	„	„	= „	27	„	„	
„ 4.— „	20	„	„	= „	32	„	„	

and of these, Nos. 2 and 4 are generally convenient. The acorns are not cup-shaped and there has been no slipping or involution of the vein in my cases. By this method, in suitable cases the whole of the internal saphena vein with about 3 inches of each of its longer tributaries can be removed and the small incisions above and below closed in twelve minutes. The removal is accomplished with less risk than by any other known method and, as the table of cases shows, with no bad result attributable to the method itself.

Apparently the first inside-out extraction was published by Keller in 1905.[7]

O'Sullivan, in April 1910,[8] was the first to publish an original inside-out extraction operation in this country. It was performed by means of a probe passed up the vein. A tourniquet was used, and the operation was done under local anæsthesia. Marmourian, in July, 1910,[9] referring to O'Sullivan's operation, mentions that inside-out avulsion had been practised at Ashton District Infirmary for two years, and in referring to the special extractor used by Babcock, quotes Murphy's opinion that Babcock's operation is "one of the simplest and most expeditious thus far devised".

Babcock's operation is well known and only a few points learnt by experience need be mentioned.

1. The anæsthetic. A local infiltration with N.P.A. (0·25 per cent novocain) over the sites of incision is often sufficient. I saw the extraction done in two cases without any general anæsthetic and the patients said it was not very painful; nitrous oxide or so-called 'instantaneous ether' may be used for it. In general, however, when numerous other veins and adjacent tributaries have to be ligated, ligated and divided, or excised, a general anæsthetic is advisable.

2. The optimum position is the low or slight Trendelenburg, the trunk inclined head downwards, the feet slung in line with it from lithotomy crutches, and sometimes the end of the table let down. The shoulders are prevented from slipping by suitable supports. This position largely empties the limbs of blood, rendering the use of a tourniquet unnecessary, which is a help as it is much in the way of the upper incision.

3. It is convenient to get the assistant to press on the thigh just below the distal end of the divided vein in the groin while the acorn tip is being entered, so as to prevent loss of blood and show up the lumen.

4. It is important to tie and divide the saphena close to the saphenous opening so as to be certain of extracting the upper ends of the internal and external femoral cutaneous branches, sometimes called the anterior and posterior branches. Sir Robert Jones drew attention to this point during the discussion of Thelwall Thomas's paper. Clinically the posterior branch is the more important of the two. The internal saphena vein may be duplicated wholly or in part, a condition that was not met with in these cases.

5. The communicating veins in the popliteal region were, as a matter of routine, ligatured and divided, although this is not part of Babcock's original proposal. The inner one usually comes away on the extractor; the outer one from the external saphenous usually communicates with the internal saphenous system in front of the knee as well as behind the popliteal space. As a routine every main dilated channel that could be seen and marked before operation was either ligatured by underrunning, ligatured and divided, or partly excised, including the external saphena, which may require extraction. The operations on the tributaries were done at a distance from the extracted ends and preferably at a tributary junction. Some fresh enlargements have been noted in the twenty cases presented and probably occurred in veins not seen and marked. In the future it may be advisable to replace this part of the operation by Zirn's[10] intravenous sublimate injection. The ends of the tributaries, where they have been broken off by the extraction,

have sometimes been noticed during the rest of the operation to be turned sideways through about 60° and even turned completely round. The broken ends are curled in towards the lumen and the blood clotted, so that probably the rest of the vein would hold the injection. If this proceeding should prove to be efficient and devoid of risk it would save a good deal of time.

Partial extraction was alone possible in 7 limbs—in 2 to the upper third of the leg, in 5 to the middle of the leg. In the remaining 96 the attempt removed the whole length of vein from just above the malleolus to the saphenous opening. When the extractor will not pass from above downwards it may usually be passed from below upwards, and sometimes half and half. The amount of bruising seems to be less when the extraction is made upwards instead of downwards, probably because the tributaries break without being displaced through an angle before they rupture. My experience differs from that given in *Medical Science Abstracts*[11] in that the main vein does not break during extraction. It is apt to be ruptured during the insertion of the instrument if the vein is tortuous and thin, but the substitution of Babcock's method for inside-out avulsion has abolished the accident of breaking the vein during the actual extraction.

As to the kind of case in which operation is indicated there may be a difference of opinion. It is extremely difficult to form any conclusion from tests as to the degree of thrombosis and carrying capacity of the deep veins of the limb. The question did not arise so much in this series ; but in civil practice, particularly in women, these factors are of great importance. Further facts as to the means adopted to decide the question, such as Mayo's elastic-stocking test, and following up the after-history over long periods to see if the operative results are in accord with the clinical decisions, are necessary.

A plethysmographic method, provided it could be arranged so as not to constrict the veins, might help us. For instance, the systolic blood-pressure and the blood-volume of the limb would be taken in the horizontal and in the erect postures. Then the rate of emptying would be noted when the patient lies horizontal and the limb is elevated to 45 degrees. The patient would stand up until the normal blood-volume was attained, and the previous observation would be repeated, but with an artificial constriction of the superficial veins above the knee. By subtraction we should obtain a value for the rate of emptying due to the deep veins. The rates of filling of the limb in the erect posture would then be recorded with the superficial veins free and also when constricted. By subtraction we should obtain a relative value of their effect in damming back the blood. These numbers would be indexed with respect to the blood-pressures and compared with the operative results five years later. The problem would be a good one for investigation by one of the new ' units '.

In the meantime, judging from the experience of the hydrostatic method of applying Unna's paste bandage in out-patient departments, the best test will be obtained by using a semi-rigid casing, rather than an elastic one, in which one can never be certain that there is not a tight constriction at some part of the limb, or that the elasticity is of the right degree.

The symptoms and signs noted as positive in the 60 cases involving 103 limbs may be set out as follows :—

Side affected	Impulse	Tortuosity	Swelling	Tiredness, Weight and Fullness	Pain	Cramp
Right (5)	4	3	—	2	—	4
Left(12)	5	5	3	2	4	7
Right and left (43)	24	44	24	18	20	36
Right of both ..	1	—	—	—	—	—
Left of both ..	6	4	—	1	2	—
Total limbs (103)	40	56	27	23	26	47

In 11 cases there were no symptoms, but in these operation was necessary in twenty-two limbs for varicosity and a varying degree of tortuosity. It is always well to bear in mind that the etymology of vărix varĭcis (a dilated vein, especially in the thighs, Celsus and Cicero) is unknown, and in the future it will be necessary to have an exact record of the impulse, whether forcible, medium, or slight, and of the distance it can be seen or felt on coughing. The degree of tortuosity present will have to be recorded, and it will not be easy to secure uniformity in this respect. We may merely be able to record it as extreme, cysts present, marked, medium, or slight. The total number of cases here is too small to warrant deductions, but the greater tendency to tortuosity and impulse on the left side when both sides are affected is noticeable, as also is the association of symptoms, particularly cramp, with impulse and tortuosity. Analyzing the negative relationship of cramp with impulse and tortuosity the following figures are available :—

Cramp was noted in 47 of the 103 limbs ; impulse without cramp was present in 9 limbs ; tortuosity without cramp in 19 ; impulse and tortuosity without cramp in 7 ; cramp without impulse in 22 ; cramp without tortuosity in 1 ; and cramp without impulse or tortuosity in 2, showing that cramp, the commonest of all the symptoms, is rarely present without some degree of tortuosity and impulse. The detection of an impulse on coughing is much more common than is usually thought. When present in the groin it can frequently be felt also just above the internal malleolus. When not detected at the malleolus it can almost invariably be felt below the knee above the main tributary junction. It is the most satisfactory of the tests for incompeteney of the valves.

The question arises as to what prospect can be held out by operative interference. Jeannel,[12] in an exhaustive and valuable paper, gives the prospect concisely in his *Table XV* as follows :—

		Résultats	
		Guérisons	Douteux et Echecs
a. Opérations qui ne visent que le reflux superficiel	1. Opération de Trendelenburg et ses dérivées	50	50
	2. Résection de la saphène interne dans son trajet fémoral ..	52	48
b. Opérations qui ne visent que le reflux profond	1. Résection de paquets variqueux isolés au tiers inférieur de la cuisse et à la jambe	74	26
	2. Résection de la totalité ou d'une partie des saphènes à la jambe et au tiers inférieur de la cuisse	46	54
c. Opérations qui visent à la fois le reflux superficiel et le reflux profond	1. Ligatures et résections étagées sur la cuisse et sur la jambe..	60	40
	2. Saphénectomie totale	95	5

The paper should be consulted. The cases were traced over periods of from one month to fourteen years, those of complete saphenectomy from a few months to seven years. They are the only results commonly quoted and available for comparison.

In the 60 cases operated upon the immediate result was good up to the time of returning to depôt. There was no injury done to the internal saphenous nerve by the extraction. Suppuration occurred in 4 cases ; three were slight and one multiple, the latter being operated on the day after the supply of spirit for disinfection was stopped. In no case did suppuration occur along the course of the extracted vein. Hardness and bruising along the course of the extraction was of a temporary nature, and in the later results has proved to be of no account.

Out of 20 cases traced, in 7 (*Cases* 2, 4, 8, 10, 14, 17, 18) the man was killed in action after periods of from five months to two years, the average being 14$\frac{3}{7}$ months and the

TABLE OF TWENTY CASES TRACED AFTER OPERATION.

Case	Age	Duration and Nature of Symptoms	Physical Signs noted and Limbs Affected	Date and Nature of Operation	Date of Report, with Result
1	18	Six months. Pain, tiredness, no cramp	Varix, with impulse to ankle. Left	Jan. 1915. Complete Babcock	Nov. 1920. Pain, swelling, tiredness both legs. A few enlarged veins left side. Four years abroad as private, and once wounded
2	19	Three years. Cramp	Varix, with impulse to ankle. Right and left	Feb. 1915. Double Babcock to upper third of leg. Local ligations with division	Killed in action July, 1915
3	27	Three years. Tiredness, swelling, 'sciatica', and cramp	Varix, with impulse to ankle. Right and left	Feb, 1915. Double complete Babcock. Local ligations with division	Nov. 1915. Very good result. Wrote when wounded. Sept. 1919, no reply
4	33	No symptoms; but rejected	Varix, with impulse to ankle. Right. No impulse left	Feb. 1915. Double complete Babcock	Sept, 1919. "The operation was successful, but the man was killed in action, Sept. 1915"
5	21	Two years. Cramp	Varix, with tortuosity. Right	March, 1915. Babcock to upper third. Local excisions. May, 1915, further excisions	Nov. 1920. Seen. Did forest work until 1917, then in line until armistice. No tiredness, no swelling; but if sits cross-legged gets cramp. Never the degree of cramp previously experienced. Scars supple. A few small veins show on inner side leg. No hardness along extraction line
6	40	Three months. Swelling, tiredness, severe cramp	Varix, with impulse to ankle. Left	April, 1915. Complete Babcock. Local ligations with division	Sept. 1919. "Never troubled since." Nov. 1920. No swelling, no tiredness, slight pain and cramp. Six months' home service, since then working as tube-work labourer
7	27	Four months. Tiredness, cramp	Extensive varix, with impulse in thigh, not leg. Right and left	April, 1915. Double complete Babcock. Local excisions. May, 1915. Excision enlarged tributary inner left appearing since first operation	Sept. 1919. "Three periods active service, thrice wounded. Went through all kinds of marches, and my legs have been all right." More enlarged veins have appeared on both sides
8	42	Twelve years. Stiffness and tiredness; worse lately after marching	Varix, with impulse to ankle. Left	April, 1915. Complete Babcock	Killed in action Oct. 1916
9	33	Three weeks. Swelling, pain in ankles, flat-foot	Varix, with impulse to ankles. Right and left	April, 1915. Double complete Babcock	Sept. 1919. "In perfect health." Nov. 1920. No pain, no cramp, no tiredness, no more enlarged veins, scars sound, 3 years' home service. "I have neurasthenia, and only do light work."

		Pain, swelling	ity, chiefly right. Impulse left, not right	Babcock and local excisions	Nov. 1920. "The veins not removed have developed greatly, and new ones have appeared." Overseas service 3 years and 8 months as signaller in line. Has cramps right and left, and symptoms of a neuroma in one scar
12	28	Six weeks. Pain, swelling, and cramp	Varix, with some tortuosity. Left side the worse. Impulse left, not right	May, 1915, Double complete Babcock and local excisions	Sept. 1919. Two periods of active service, and twice wounded, No symptoms since operation, and can walk well.
13	45	Nine months. Pain, swelling, tiredness and cramps, especially left thigh	Varix, right and left; left the worse	June, 1915. Double complete Babcock and local excisions	Sept. 1919. "Terrible for cramps, and left leg swells at times." Nov, 1920. Is doing heavy work as mason's labourer and says he is quite well.
14	36	Fifteen years. Swelling, pains in the joints and cramps, left side the worse	Varix, with impulse to ankle, left. No impulse right	Oct. 1915. Double complete Babcock and left local excisions	Killed in action April, 1917
15	26	Three months. Tiredness, swelling, cramps, left side the worse	Varix, with impulse to ankle, left. No impulse right	Oct. 1915. Double complete Babcock and local excisions	Nov. 1920, Seen. Home defence until Sept. 1916, then 8 months at front, wounded, and 1 year in hospital. No swelling, no enlarged veins, scars sound, no cramps, able to walk well
16	30	Eight years. Cramp	Varix, with impulse in thigh, right, with big impulse to ankle left, and great tortuosity with cysts	Oct. 1915. Double complete Babcock, with local excisions left side with flaps which sloughed and required grafting	Nov. 1920, The man has pain, cramp, and more enlarged veins. He is dissatisfied with the result, but did 3 years' home service and farm servant since then.
17	34	No symptoms	Extensive varix, with tortuosity, but no impulse. Right and left	Jan. 1916. Double complete Babcock and extensive local ligations with division	Killed in action Aug. 1916. Prior to that no symptoms
18	30	Three years. Swelling, tiredness, cramp, worse latterly	Varix, right and left	Jan. 1916. Double complete Babcock and local excisions	Killed in action Oct. 1917
19	26	One-and-a-half years. Cramp in leg and foot. Three times rejected	Varix, with impulse left	Feb, 1916. Left complete Babcock and local excisions, including veins on foot	Nov. 1920. Seen. "I was able to do longer marches than I ever could have done without operation." No pain, no swelling, no tiredness, no cramp, no enlarged veins, scars supple, no hardness along extraction track. Was 273 days in France, and twice wounded. Now doing gardening work
20	33	Fifteen years. No symptoms	Varix, with marked thickening and tortuosity left, right neither thick nor tortuous. Impulse not recorded	? date, but before Aug. 1916. Right complete Babcock. Left numerous excisions	Sept. 1919. "Condition satisfactory." Two periods of active service

median 18 months. It is difficult to imagine a man being able to stand the strenuous training and severe conditions of active service prevailing at that time if the result had been other than good. These cases represent 13 limbs, showing 6 with impulse as far as the ankle, 2 with tortuosity, and 1 with impulse as far as the ankle and tortuosity. In two of these cases (4 limbs) there had been no symptoms prior to operation, and in each there is evidence that the operation had been harmless (7 months).

Of the 11 men who returned, the result may be called excellent in 6, viz.: *Case* 5 (5 years 8 months); *Case* 6 (5 years 7 months); *Case* 9 (5 years 7 months); *Case* 12 (4 years 4 months); *Case* 15 (5 years 1 month); *Case* 19 (4 years 9 months). These cases represent 9 limbs, 5 showing impulse as far as the ankle and 3 tortuosity. The result may be called good in 3 (*Cases* 3, 7, and 20), mediocre in 2 (*Cases* 1 and 13), and bad in 2 (*Cases* 11 and 16), in which symptoms had existed for eight years prior to operation. If it is allowable to add the 'killed in action' cases to the 'excellent' and the 'good', the percentage of good results is 80. This is ten per cent less than Balfour[13] reports for Mayo's[14] (with partial Schede) operation, but his results are appraised on a lower standard than mine.

It is clearly important to operate as soon as possible after symptoms appear, and in certain cases it may be advisable to operate when signs alone are present, as for instance when the patient is likely to be going to a tropical country or to be engaged in heavy labouring work or work which involves long standing. With increasing experience along the lines indicated there is no doubt that a great improvement may be expected in the results. In this connection the R.A.M.C. in peace time should, with their unrivalled means of tracing the patients over long periods and of having them examined and reported on by a medical officer, be able to furnish extremely valuable statistics in the future.

SUMMARY.

1. Babcock's extraction operation, in cases taken early, results in removing the whole of the internal saphena vein, with up to about three inches of each of its tributaries, through two small incisions, in twelve minutes.

2. The extraction operation combined with local excision of all the tributary junctions of the external and internal saphenous systems, and the extraction or excision of the external saphena vein, should be regarded as the operation of choice in ordinary cases if the symptoms are to be relieved for long periods.

3. No bad results are directly attributable to the extraction part of the combined operation.

4. Further information is required as to the frequency of occurrence of duplication or partial duplication of the internal saphena vein.

5. An investigation by a plethysmographic method of the relationship between symptoms and the carrying capacity and retarding effects of the superficial and deep veins is called for.

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A STUDY OF LOOSE BODIES COMPOSED OF CARTILAGE OR OF CARTILAGE AND BONE OCCURRING IN JOINTS. WITH SPECIAL REFERENCE TO THEIR PATHOLOGY AND ETIOLOGY.*

By A. G. TIMBRELL FISHER, London.

I.—INTRODUCTORY.

The subject of loose bodies in joints is not only of considerable practical importance, but in addition it constitutes a pathological problem of very great interest, the solution of which has taxed the ingenuity of surgeons and pathologists from the time of Ambroise Paré until the present day. It is scarcely surprising therefore that the literature upon the subject is great, and the nomenclature diverse. Unfortunately, the subject of loose bodies in joints, like that of internal derangement of the knee, in spite of the progress that has been made in recent years, is still surrounded by a cloud of mystery and imagination which not infrequently brings discredit upon our profession, and under cover of which the charlatan and 'bone-setter' pursue their dangerous and unscientific methods. This cloud can only be dissipated by knowledge of underlying pathological principles.

The present article does not discuss the group of loose bodies comprising those formed of unorganized fibrin, fibrous tissue, fat, etc.; but confines itself to those bodies formed of cartilage, or of cartilage and bone combined, occurring in joints. Foreign bodies in joints also form a class by themselves and do not come within the scope of this paper.

Historical Summary.—We find the first reference in surgical literature to loose bodies in the works of Ambroise Paré. This great French surgeon in the year 1558 successfully removed a loose body or 'stone' from the knee. We read that the 'stone' was of the size of an almond, very white, hard, and polished. Paré was much influenced by the superstitions of his age, and includes loose bodies in his chapter on monstrosities. This does not prevent our doing homage to this great surgeon, who was the first to possess the surgical courage and skill to remove a loose body from a joint.

Alexander Monro, in 1738, was the first to recognize that loose bodies might be derived from the articular ends of the bones.

The great John Hunter considered that these bodies arose from blood extravasated after injury into the joint. He wrote: "This blood when it is extravasated into a cavity is not absorbed, nor loses its living principle, but becomes vascular and afterwards membranous, cartilaginous, or bony according to circumstances". A Hunterian specimen demonstrates another of the views of John Hunter upon the causation of loose bodies in joints which is often overlooked. It is referred to by Hunter as follows: "In 1759 I stripped the bones of an old woman that died in St. George's Hospital, and in taking off the flesh about the knee, and cutting into the capsule, there came out a stone or bone about the size of a flattened nut. On turning down the patella, I saw that the cartilage was almost eroded off it in parallel grooves, and upon the upper edge of the patella there was an exostosis—this was partly divided into two, and both seemed to have been broken off the patella and closely united by a ligamentous substance". And he ends his description of this case by saying: "These explain those cases in surgery where we find a movable cartilage or bone in the joint of the knee".

A great impetus was given to the investigation of the problem by the discovery, by Kölliker, of cartilage cells in the normal villi of the synovial membrane, and by the

* Embodying the Hunterian Lecture delivered at the Royal College of Surgeons of England.

observations of Rainey, and their theory that these cells might under certain conditions proliferate and form loose bodies in a joint. The theory that loose bodies might be derived from the articular surface fell temporarily into disfavour.

However, in many cases the body so resembled a portion of the articular surface that its origin from the latter could not be denied, and, to account for their source therefrom, Sir James Paget brought forward the theory that they were detached by 'quiet necrosis'. He says: "How can such pieces of articular cartilage be detached from living bone? They cannot be chipped off—no force can do this . . . these bodies are sequestra exfoliated after necrosis of injured portions of cartilage without acute inflammation". König, although he does not deny the traumatic origin in certain cases, considered the majority were detached by a spontaneous dissecting osteochondritis, which, without any injury to the joint, leads to detachment of pieces of the articular surface; although he admits that in the cases he examined microscopically all traces of the morbid process had disappeared! Unfortunately, many of his would-be supporters, particularly in America, cannot have read his original article; for they substitute for 'dissecans', or dissecting, the word *desiccans*, and one author has brought his facts into line with the error in nomenclature by finding that the loose bodies he described were 'desiccated'.

II.—PATHOLOGY AND SYMPTOMATOLOGY.

The loose bodies of cartilage, or of cartilage and bone, under consideration, may be classified into three groups.

Group I.—Loose bodies occurring in connection with some more or less general pathological process affecting the joint, such as: (*A*) *Osteo-arthritis*; (*B*) *Tabes*; (*C*) *Tuberculous disease accompanied by necrotic caries*; (*D*) *Acute arthritis due to infection.*

Group II.—Loose bodies occurring in joints that are otherwise apparently normal: (*A*) *Bodies having the microscopic, and frequently the macroscopic, appearances of detached portions of the articular surfaces*; (*B*) *Bodies derived from inter-articular fibrocartilages*; (*C*) *Bodies formed from detached epiphyses not forming portions of an articulating area.*

Group III.—Synovial chondromata, laminated and non-laminated: (*A*) *Single*; (*B*) *Multiple*; (*C*) *Diffuse.*

GROUP I.

LOOSE BODIES OCCURRING WITH SOME GENERAL PATHOLOGICAL PROCESS AFFECTING THE JOINT.

A.—Loose Bodies occurring in Osteo-arthritis.

(1) *Synovial chondromata*; (2) *Detached osteophytes*; (3) *Detached epi-articular ecchondroses.*

1. Synovial Chondromata in Osteo-arthritis.—

These will be dealt with below under *Group III*, as they present the same naked-eye and microscopic appearances as the synovial chondromata that occur unassociated with osteo-arthritis. They cannot be said therefore to be the typical osteo-arthritic loose body, which distinction belongs to the detached osteophyte to be dealt with below.

Fig. 349 (Spec. 712, St. Bart.'s Hosp.) depicts pedunculated synovial chondromata occurring in an elbow-joint affected with osteo-arthritis.

2. Loose Bodies formed by Detached Osteophytes.—

As we have already seen, it is to John Hunter that we owe the first description of this mode of origin of loose bodies. Bodies of this category have certain definite features which differentiate them from the other varieties, and by which they may be at times readily recognized. Before describing these, however, it is necessary to recall briefly how an osteophyte is formed. If we examine a cartilage-clad articular surface showing commencing osteo-arthritic changes, we find that those parts of the articular cartilage most exposed to pressure are undergoing fibrillation, whereas at the periphery of the articular area the

edge of the articular cartilage is lipped, forming peri-articular ecchondroses (Shattock). Before long the deeper part of the ecchondroses becomes bony, and the ossification spreads until a nodular peripheral chondro-osteophyte is formed, covered by a layer of cartilage. This cartilage may proliferate, and ossification may continue simultaneously until large masses are formed.

FIG. 349.—Synovial chondromata in osteo-arthritic elbow-joint.

These chondro-osteophytic formations are peculiarly exposed to injury in certain situations, and it is not surprising therefore that they may become detached, either completely or incompletely, and in the latter case are often found attached by pedicles of varied thickness to the joint margins.

When completely detached, the fractured surface of the chondro-osteophyte may be recognized, but later this may become covered by outgrowth from the surrounding cartilage.

FIG. 350.—Detached osteophyte. (× 2.)

Fig. 350 is an excellent example of a detached osteophyte forming a loose body which was removed by Sir Charles Gordon Watson, to whom I am indebted for the specimen. The narrower portion uppermost in the drawing represents the base of the osteophyte. The line of detachment may be recognized by the narrow area of bone, the cancellous tissue of which has been subsequently closed in. The body lay in the inner part of the joint cavity; it was attached by a delicate secondary adhesion to the synovial membrane, and the area from whence it was derived could be seen upon the inner margin of the internal femoral condyle. The patient from whom the body was derived was kicked upon the knee when playing football

six years previously. He was confined to his bed for a week with acute traumatic synovitis. Since that date he has had several attacks of pain and swelling after undue exertion, and two years ago first noticed a loose body on the inner side of the joint. More recently the joint has temporarily 'locked' on several occasions.

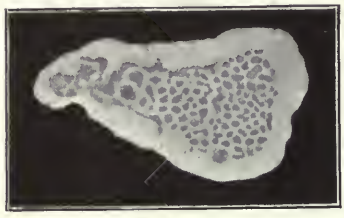


FIG. 351.—Detached osteophyte. (× 2.)

In *Fig.* 351 is shown in section a somewhat pyriform osteophyte from another case. The more pointed extremity depicted on the left of the drawing is less thickly covered with cartilage than elsewhere, and may be regarded as the spot where the osteophyte was attached to the parent bone, the fractured surfaces having become covered with cartilage of new formation.

Microscopical examination of this chondro-osteophyte (*Fig.* 352) shows features of great interest, which clearly differentiate this variety from the two other types to be described later, with which it is liable to be confused, i.e., the synovial chondroma and the 'classical' type of loose body derived from the articular surface. A section through the entire body shows that the periphery consists of well-developed *fibrocartilage* with comparatively few, but uniformly distributed, cells. The latter differ from those of connective tissue in that the nuclei are spherical, although they are as yet unsurrounded with capsules. This fibrocartilage is invested with a zone of fibrous tissue furnished with flattened cells as in a perichondrium. In this fibrocartilage occur areas of hyaline cartilage. The bone in the centre consists of well-developed cancellous tissue, but is quite dead. The lacunæ are empty, and devoid of any stained elements. The contents of the spaces are mostly groups of fat-cells, but there are no stained nuclei either in the fat-cells or other tissues. At the junction of the osseous centre and the surrounding cartilage there is, in places, a zone of calcified cartilage between the fibrocartilage and the proper dead cancellous bone, *the cartilage cells in this zone being alive* but the bone-corpuscles dead. The overlying cartilage has nowhere the characters of normal articular cartilage, and there are no proper elongated or other groups at the free aspect.

To sum up: A detached osteophyte forming a loose body in a joint has definite naked-eye and microscopic appearances by which it may be recognized. It is very unusual for more than two or three of these bodies to be found in the same joint, and there is often only one of this variety present. In the same joint, however, there may co-exist cartilaginous loose bodies derived from synovial fringes.

FIG. 352.—Microscopical section of periphery of osteophyte shown above.

3. Detached Epi-articular Ecchondroses.—

Professor Shattock was the first to point out that bodies of the same essential nature as the peri-articular ecchondroses growing from the articular margins might arise in the substance of the cartilage covering the normal bone. This takes place by local hyperplasia of the cartilage, in which central ossification subsequently occurs (*Path. Trans.* xl). (Spec. D97, St. Thomas's Hosp.). *Fig.* 353 is a knee-joint showing advanced osteo-arthritic

changes. The articular surfaces of the patella and femur are raised in many rounded eminences of varying size. A section carried through the patella discloses the normal contour of the subjacent bone, and an intervening zone of articular cartilage between this and the endogenous chondro-osteophytes. The epi-articular ecchondroses in this and other cases are associated with the ordinary marginal outgrowths.

FIG. 353.—Epi-articular ecchondroses.

These observations (as Professor Shattock observes) suggest that in certain cases the separation of such might lead to the production of loose bodies of a kind similar to those which are at times detached from the articular margins. For among the nodular projections over the border of the femoral trochlea, some, which a vertical section shows to overlie the original cartilage, admit of a limited degree of movement.

In the museum of St. Thomas's Hospital there are the lower ends of two femora (from the same individual), embedded in the inner condyle of each of which there lies an almost completely detached 'loose body' (*Fig.* 354). Each of the bodies is of a regularly

FIG. 354.—Inner condyle of femur showing an almost detached ecchondrosis lying in articular area.

oval shape; its thickness considerably exceeds that of the normal articular cartilage, and it is calcified or ossified almost throughout; the pit in which it rests is, like the under surface of the loosened body, invested with fibrocartilage. "If we conceive a localized hyperplasia in the substance of the articular cartilage, a central calcification or ossification of the new formation, and a differentiation, by fibrous metaplasia, of such an enchondrosis from the surrounding cartilage, we should have, I think, a fairly satisfactory explanation of this curious specimen."

B.—Loose Bodies occurring in Tabes.

These resemble the bodies described in the last group, but all the processes tend to become greatly exaggerated, so that the loose bodies, whether formed from synovial fringes or by detachment of osteophytes, are as a rule larger. In tabetic joints, especially in the hypertrophic form, the osteophytes may be indeed enormous; moreover, the formation of bone involves the planes of connective tissue between the capsule and the synovial membrane, so that the joint may be surrounded eventually by bony masses, sometimes accurately articulated.

Fig. 355 (Spec. 824, St. Thomas's Hosp.) shows several of these features: (*a*) In the much dilated posterior compartment of the joint can be seen a large, smooth, and rounded loose body of synovial origin; above this the capsule is distended by two others of larger size. (*b*) From the anterior margin of the femur a large osteophyte extends upwards with a firm bony basal attachment. (*c*) Between the patella and tibia there is a pedunculated loose body formed by a partially detached osteophyte.

Fig. 355.—Tabetic knee-joint in vertical section.

Fig. 356.—Tuberculous sequestrum.

C.—Loose Bodies occurring in Tuberculous Disease accompanied by Necrotic Caries.

Tuberculous necrosis of considerable portions of bone is not a common condition. It affects more frequently the articular end of the femur, and is probably due to interference with the blood-supply of the affected portion, which may account for the wedge-shaped or conoidal form of these sequestra. A remarkable feature is the slowness of the process by which their separation is accomplished. A specimen in St. Bartholomew's Hospital is a good example of this condition. It shows a tuberculous sequestrum in each condyle of the lower end of the femur. Neither sequestrum is completely separated. *Fig.* 356 (Spec. 731,

St. Thomas's Hosp.) shows the upper end of the humerus with a wedge-shaped sequestrum which was lying free in the cavity of the joint, forming a loose body. The head of the bone has been almost entirely destroyed by caries, and there is a wide perforation of bone in the region of the bicipital groove. A remarkable feature is the highly-polished surface of the loose body, which is well shown in the drawing. The eburnation probably took place before the portion of bone underwent necrosis.

D.—Loose Bodies occurring in Acute Arthritis due to Infection.

These occur in the following forms: (1) Flakes of necrotic articular cartilage of variable size; (2) Bony sequestra; (3) The whole of the articular end, when the epiphysis is intracapsular, may necrose and be found quite loose in the joint.

GROUP II.

LOOSE BODIES FORMED BY DETACHMENT OF A PORTION OF THE ARTICULAR SURFACE AND OCCURRING IN OTHERWISE NORMAL JOINTS.

General Characteristics.—

1. They occur more frequently in males than in females.
2. The commonest age incidence is between the years of fifteen and twenty-five.
3. The type of loose body most frequently seen I have termed the 'classical' form. This form has the following characteristics: Shape circular or oval. Size, that of an almond. Section, plano-convex. Surfaces—The convex surface has the typical appearance of articular cartilage, whereas the flattened surface is more irregular and may be rough, lowly nodulated, or smooth, according to the degree of proliferation that has taken place. The borders are smoothly rounded (*Fig.* 357, personal specimen).

Fig. 357.
'Classical' form: both aspects.

4. Their commonest site is the knee, next in frequency the elbow. Their presence has been recorded, although rarely, in the shoulder, hip, ankle, wrist, and other joints. In the case of the knee-joint they are usually derived from the articular surface of the femur or patella, and but rarely from that of the tibia.
5. Although usually single, occasionally two or even three of these bodies may be present in a joint.
6. The bodies may be completely or incompletely detached or may acquire a secondary adhesion to the synovial membrane. When incompletely separated they are usually attached by a hinge of articular cartilage to the margin of a defect or loss of substance in the articular surface which corresponds in size and shape to the loose body. In cases where more than one body is present, these may be quite free, or one may be incompletely detached and the remainder free.
7. Cases are recorded where such a gross detachment by injury as the head of the femur or of the radius may occur and form a loose body in the joint.
8. Their continued presence in a joint may bring about secondary changes of an osteo-arthritic nature.
9. These loose bodies themselves undergo certain remarkable changes in the joint which will be dealt with in detail below.

10. The part that trauma plays in their etiology has been a subject of great controversy, and we will defer our conclusions upon that question until we have critically examined the series of cases to be next described.

11. They are occasionally bilateral and symmetrical (Bowlby, Clutton, Weichselbaum).

A.—Loose Bodies having the Appearances of Detached Portions of the Articular Surfaces.

Classification.—

I have adopted the following subdivisions: (1) Recent detachments. Bone (where present) and articular cartilage living. No proliferative changes in articular cartilage; (2) Bodies whose sojourn in the joint has been longer. The articular cartilage shows proliferative changes. The 'classical' type of loose body; (3) Marked degree of proliferation of cartilage; (4) Excessive proliferation of cartilage; (5) Feeble proliferation of cartilage; (6) Formation of new bone from the osteogenetic tissue in the cancellous spaces accompanying the formation of secondary adhesions, or incomplete detachment.

1. *Recent detachments.*—

In this series a portion of articular cartilage, with or without a layer of the subjacent bone, is detached by direct or indirect violence. The following cases are typical examples representing four different varieties: *Cases* 1 and 2, Detachment of articular cartilage and bone by direct violence. *Case* 3, Detachment of articular cartilage and bone by indirect violence. *Case* 4, Detachment of articular cartilage by direct violence. *Case* 5, Detachment of articular cartilage by indirect violence. I am indebted to Sir Charles Gordon Watson for the accompanying description of an injured elbow-joint:—

Case 1.—The head of the radius was lying completely free in the elbow-joint, and, when the joint was opened, dropped on to the operation-table. The patient, a man, age 30, fell in the street and struck his elbow against the kerb. When examined at the Metropolitan Hospital, he was found to have dislocation of both bones of the forearm backwards. This was reduced. Subsequently the joint remained painful and swollen and was *x*-rayed, when the loose body was seen. The subsequent progress of the case was uneventful.

In intracapsular fracture of the neck of the femur the femoral head may form a loose body in the joint, usually with a distinct pedicle formed by the ligamentum teres; only a few delicate bands formed from the synovial membrane.

Case 2.—(Spec. 1936A, Museum, R.C.S.). In this case the loose body was attached by a pedicle of fibrous tissue, and was derived from the articular surface of the patella in its lower part. It is a somewhat wedge-shaped piece of bone, covered on one aspect by articular cartilage. The specimen shows well the vertical structure of the cartilage, which is typical of articular cartilage when fractured at right-angles to its surface. It was presented to the museum by Sir A. Pearce Gould, to whom I am indebted for permission to publish the case. The body was removed by him from the knee-joint of a lady, age 31, who fell on her left knee with considerable force when alighting from a taxi-cab.

From notes accompanying the specimen we learn that the knee rapidly swelled, and when seen a few days afterwards the synovial cavity was apparently distended by an effusion of blood. Moderate flexion of the knee was not painful, but any attempt to extend it caused a sharp stabbing pain through the front of the joint. Lateral movements of the patella were painless, as was also movement vertically downwards; but any attempt to move the bone vertically upwards immediately caused sharp pain.

A skiagram showed that a small fragment of bone had been broken off the hinder part of the articular surface of the patella and was hinged downwards, so that what had been the highest point of the fragment was now directed backwards and impinged upon the articular surface of the femur. At the operation the knee-joint was found to be full of blood and the fragment as described above. On cutting through a few fibres by which it was adherent to the ligamentum patellæ, the piece of bone was easily removed. The cavity from which it came was easily seen and felt at the operation. The patient made an uninterrupted recovery. From an examination of the specimen, and from the history and operation findings, it is clear that this is a case of detachment by direct violence of a portion of the patellar articular surface consisting of bone and cartilage.

Case 3.—(Spec. W.O. 1777, Museum, R.C.S.). This is an excellent example of traumatic detachment of almost the whole of the articular cartilage of the external condyle

of the femur, probably by indirect violence. The specimen is from the Wharncliffe Hospital at Sheffield, and the following short history is appended :—

"While on military duty in France, the patient slipped on a stone and fell. He was unable to straighten his leg, and the knee became very swollen. When examined in England ten days later the knee presented signs and symptoms suggesting injury of the internal semilunar cartilage, effusion in the joint, pain over internal lateral ligament, and considerable limitation of movement. *X*-ray examination showed fracture of the external condyle of the femur with displacement of the fragment inwards between the joint surfaces. Three weeks after the accident the joint was opened by dividing the patella vertically, and the detached piece of bone and articular cartilage was removed. It was adherent to the condyle, but displaced inwards and forwards. The patient left the hospital eleven weeks after, walking well and able to flex his knee to a right angle".

Case 4.—*Fig.* 358 represents diagrammatically the position found at operation of a loose body now in the museum of St. Thomas's Hospital. The free aspect presented a fissure on one side. The inferior portion was extensively and finely fissured, the separation having taken place through the brittle, calcified, deep layer of the articular cartilage.

The patient was a young man, age 24, whose principal complaint was of pain in the right knee on walking. In September, 1920, after a game of football, the knee was swollen ; and the swelling and pain increased very greatly after playing again a week later. The knee was put in plaster for five weeks, but without much improvement.

X ray showed a little erosion of the anterior surface of the femur at the joint line, but no evidence of a loose body. Mr. Sargent opened the joint by splitting the patella vertically. A note by the dresser states that "examination of the joint then showed that the cartilage over the external condyle of the femur was suffering from 'Paget's quiet necrosis'". Mr. Sargent adds that "the piece of articular cartilage was completely separated from the bone beneath, but was firmly continuous with the normal cartilage for two sides of a square, and was lying flush with the normal cartilage on all four sides" (*Fig.* 358).

When it was removed, a bare area of bone was left, about 1 in. long by $\frac{3}{4}$ in. wide, and depressed at least $\frac{1}{8}$ in. from the surrounding cartilage. The edges all round were clean cut, even where complete separation existed before operation, and there was no evidence of attempt at re-formation of cartilage.

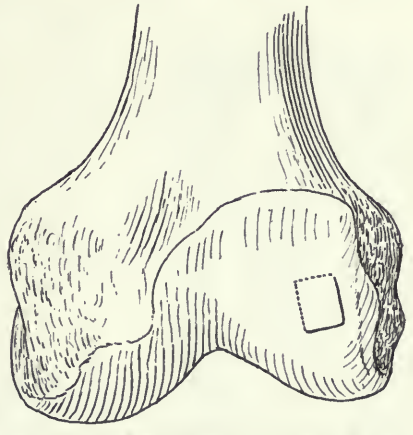


FIG. 358.—Diagram of loose body (*Case* 4) *in situ*.

The sequence of events would appear to have been that during the first game of football he received an injury to the external condyle that caused a slight separation of a portion of articular cartilage, and that during the second game the separation was increased, causing increased disability. The traumatic origin of the body is clearly demonstrated by the fissured appearance of the deep surface ; these fissures traverse the calcified zone of the articular cartilage. That it cannot be due to a process of necrosis is also clear, because it is composed of living cartilage and is not a sequestrum.

Indirect injury as a cause of a detachment of a portion of the articular surface has been so overlooked that it may be well to give the following typical example in which the loose body consisted of articular cartilage only.

Case 5.—(Spec. 826A, St. Thomas's Museum). A portion of articular cartilage, roughly quadrilateral in shape, that was removed from the knee-joint of a youth, age 17. The edges of the body are not smoothly rounded off, but on three sides are somewhat sharp and irregular as if recently fractured. On the fourth side the tissue is fibrous, the latter being evidently the ligamentous attachment.

Two days before his admission the patient felt something suddenly give way in his right knee on lifting a heavy weight. About an hour afterwards the joint became swollen, and when walking something seemed to catch so that for a moment he could not straighten his knee. There was very little pain. Next day he found there was a movable body in the joint. He was quite certain that he had received no other blow or injury. There was no history of any previous illness.

The microscopical appearances are as follows: A vertical section, excluding the smooth or free surface but including the deep, shows that the body consists of normal hyaline cartilage with rows of cells set chiefly in the vertical direction, though some are somewhat oblique. More deeply this direction is less regular, some of the groups lying almost horizontally. The cell nuclei are well stained (with hæmatoxylin) throughout.

On the deep aspect the matrix around certain of the cell groups is infiltrated with calcareous granules. Neither end of the section (which includes that of the actual specimen) shows any signs of change, but is clearly *fractured* without rounding of the edges on the deep aspect. There is no trace of bone on the deep aspect. In regard to the line of detachment, this is in places quite unaltered, but in others the line is minutely scalloped, the pits corresponding to groups of cartilage cells which have escaped. But there is no trace of cell proliferation, and no invasion of any kind with polymorphs.

The part has every appearance, therefore, of having been detached by trauma. Owing to the absence of any history of direct injury, this specimen has been until the present regarded as an example of 'quiet necrosis'. The microscope, however, has now shown that this theory of origin of the specimen is untenable, and we learn also that portions of cartilage may be avulsed by ligamentous strain reinforced by muscular action.

2. *Loose bodies in which the cartilage shows proliferative changes. The 'classical' type of loose body.*—

In this subdivision a few cases only out of the large number examined will be passed under review. Although they are all alike in showing proliferation of cartilage, they present certain minor differences.

FIG. 359.
'Classical' type. (×2.) *Case* 1.

The principal naked-eye features of this subdivision have been already described. It will be sufficient merely to draw attention again to the fact that the margins of the bodies comprising this group, instead of showing signs of recent traumatic detachment, are smooth and rounded.

Many different theories have been held as to their origin: but I shall attempt to show that they are portions of the articular surface detached by trauma, and not by any pathological process, and which have continued to grow until, as we shall see later, their origin may be obscured.

In *Fig.* 357, as will be seen by reference, the loose body is a typical example of the 'classical' form. On the smooth convex surface an oblique groove is seen to be present. And a study of the section of the body (*Fig.* 359) shows that this groove corresponds to a fracture of the subjacent bone, down which has penetrated an offshoot from the deeper layer of the articular cartilage. The section also shows the articular cartilage at one end spreading over the fractured surface. I desire to lay emphasis upon the groove on the surface and upon the fracture of the subjacent bone, as it affords additional evidence of the traumatic origin of these bodies. There is a tag-like portion of fibrous tissue attached to one of the long borders. The history appended to this specimen is as follows:—

Case 1.—E. J. D., 25, came under my care in November, 1919, with the following history:—Before the war he had been a miner; he had never had any illness that he could remember, and had never had any joint trouble. In January, 1915, he joined the Royal Field Artillery, and almost immediately commenced to undergo the strenuous riding-school exercises. After a short time he noticed that his knee would occasionally become painful and swollen after riding. The pain and swelling recurred at intervals after strenuous exercise for about two and a half years. In August, 1917, his knee suddenly became fixed in the extended position as he was getting up to leave a train, and rapidly swelled. He was admitted to hospital with the knee locked in extension. He was treated for some months as a case of 'arthritis', and the limb was immobilized by splints. The treatment caused the swelling to subside, but whenever he attempted to walk the pain and swelling recurred, and the limb was immobilized once more. After a long period of immobilization the tendency for pain and swelling to occur after exercise subsided, and he was ordered a course of gymnastic exercises to remove stiffness that was present, and he was so far improved that he was able to return to duty in February, 1918, and returned to France again the following month. The

result was disastrous: the pain and swelling constantly recurred, and at length, in December, he was discharged the service permanently unfit. After discharge his symptoms continued, but in addition he became subject to attacks of severe pain in the joint which caused him to fall to the ground.

In November, 1919, he was going up some steps, when his left knee suddenly 'twisted inwards' and became locked in a semiflexed position, so that he was unable to straighten it.

When I saw him there was a considerable amount of effusion in the joint, and any attempt to extend the leg upon the thigh caused severe pain, more marked beneath the patellar ligament. At first sight this appeared to be a case of internal derangement of the knee due to injury and displacement of the internal semilunar cartilage. However, as all attempts to unlock the joint were unsuccessful, the patient was *x*-rayed and a loose body revealed. At operation I found the loose body lying in the depression of the articular surface of the external condyle of the tibia, between the external semilunar cartilage and the tibial spine. It was easy to see how its position mechanically blocked full extension of the leg. It was attached by a pedicle to the posterior crucial ligament in the region of the intercondylar notch. After division of the pedicle the loose body was removed, and the patient made an uninterrupted recovery.

From a consideration of the history it appears probable that during the riding exercises a portion of articular cartilage was gradually detached, probably by ligamentous strain or muscular spasm, and that eventually it became completely detached and caused the first locking of the joint. Afterwards the body perhaps acquired a secondary attachment to the synovial membrane over the crucial ligament, which, on stretching, gave rise to the second period of locking. Incidentally the history shows the difficulties and pitfalls that lie in the path of the clinician in these cases. The patient's condition remained undiagnosed for nearly four years; he suffered much pain and discomfort, and was eventually discharged 'permanently unfit'. An exploratory arthrotomy might have revealed the condition at once, spared him years of suffering, and supplied another soldier for the firing line.

Microscopical appearances.—A portion cut from the dried specimen after immersion in water regained its normal appearance; and microscopic sections, after staining with hæmatoxylin, displayed well-stained cartilage cells throughout, i.e., it is not a sequestrum.

Case 2.—W. G., age 20, came under Mr. Percy Sargent's care in May, 1920, with the history that nine months ago he 'ricked' his right knee whilst swimming, and experienced severe pain in the outer side of the joint, and almost immediately after noticed a freely movable body in this situation. No locking occurred, but movements were painful. Afterwards the knee was apt to give way suddenly about once a fortnight, with excruciating pain—the loose body on these occasions being felt as before at the outer side of the joint. There was never any actual locking.

On admission, the knee was slightly swollen and the synovial membrane thickened. Movements of the joint were full, and no loose body could be felt. There was some wasting of the thigh. Mr. Sargent obtained access to the joint by the vertical median division of the patella. The body lay quite loose behind the patella.

The loose body has the characteristics of the 'classical' type already mentioned. The rounded bodies are well seen, and the deep surface shows that the articular cartilage has extended from the margin of the body over the surface of the bone. This process is more advanced than in *Case* 1.

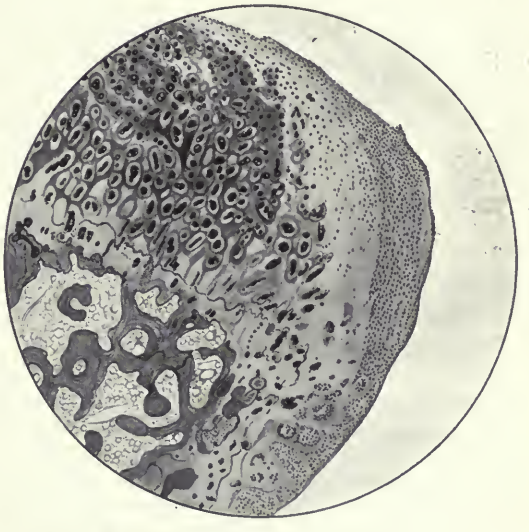


FIG. 360.—Microscopical section of free edge of *Case* 2. ($\frac{2}{3}$ *obj.*)

Microscopical appearances.—*Fig.* 360 shows the edge of the loose body (2-in. objective). From the fractured edge of the original large-celled articular cartilage a cushion of small-celled cartilage has been produced, which extends over the edge and over the under side of the fractured bone. The bone itself is necrosed,

the corpuscles in the trabeculæ ceasing to take a nuclear stain. The connective tissue within the cancellous spaces is quite dead; the forms of the fat-cells in the cancellous spaces, however, being still recognizable.

Fig. 361 represents the appearances as seen under a higher power ($\frac{2}{3}$ objective) and includes a portion of the detached surface. At the top of the specimen is seen the free surface of the reparative tissue or 'callus', which has spread from the proliferating fractured edge of the articular layer, over the opposite aspect of the fractured surface of the bone, as indicated by the fissure between the two.

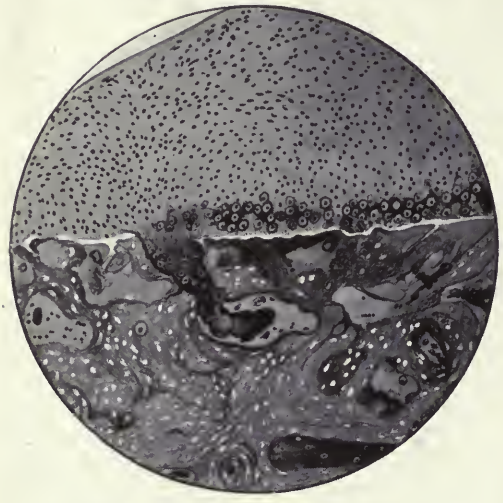


Fig. 361.—Microscopical section of under surface of *Case* 2. ($\frac{2}{3}$ *obj., reduced.*)

The reparative tissue is developed well on the deep aspect, the cartilage cells being furnished with quite well-pronounced capsules. One process is shown which has intruded itself into one of the cancellous spaces laid open by the fracture. At the lower right-hand side, another elongated cancellous space is completely filled with a deeper intrusion of cartilage, the matrix of which is coloured a vivid blue; there were several adjacent spaces occupied with similar newly-formed cartilage. The lacunæ of the osseous trabeculæ are quite empty, the bone itself being dead.

Case 3.—(Spec. 1353.I, Museum R.C.S.). This loose body is biconvex, and is composed of cancellous bone covered on one side by a layer of articular cartilage. It is to be particularly noted that the articular cartilage is spreading over the fractured surfaces of the bone.

The body was successfully removed by Sir Frederic Eve in January, 1907. Five months previously the patient sprained his right knee; this accident was followed by occasional locking of the joint accompanied by swelling. When admitted under Sir Frederic Eve there was fluid in the joint, but movements were free. A loose body could not be felt, but was revealed by radiographic examination. Eight fluid ounces of straw-coloured fluid were withdrawn by aspiration, and the loose body was extracted through a longitudinal incision on the inner aspect of the joint. "It lay in a pit in the centre of one of the articular surfaces."

Case 4.—(Spec. 647, Museum, R.C.S.) This specimen is described as follows in the Catalogue of Sir James Paget, 2nd Edit., 1882:—

"A large piece of cartilage and bone of the shape and about half the average size of a patella removed from a knee-joint. It may be regarded as a portion of one of the condyles of the femur, which, probably after injury, was separated by a process similar to necrosis, but without acute inflammation. The articular cartilage is thinly extended over the edge of the bone. Presented by Sir Everard Home."

This specimen, although unfortunately there are no clinical notes attached, is of great interest from its historical associations with Sir Everard Home and Sir James Paget. The microscopical appearances are very similar to those seen in Mr. Sargent's case. The new tissue on the fractured surface is small-celled cartilage, the matrix of which in places is finely fibrillar. The groups of cells run vertically or obliquely, and at the free surface more horizontally. Near the bone the cartilage cells are larger, and in places calcification of the matrix has taken place in the immediate vicinity of what is clearly a fractured surface of cancellous tissue. At the middle of the lower free surface the cartilage over it is thin, large-celled, and the matrix is calcified.

As in Mr. Sargent's case, the cartilage has penetrated the cancellous spaces beneath it, and no stained bone-corpuscles lie in the trabeculæ around this intruding reparative

cartilage. A curious thing is that (as in Mr. Sargent's case also) the cartilage has partially penetrated into the dead tissue of the cancellous spaces, and, what is more, that isolated cells with capsule of cartilage are scattered in this necrotic soft tissue. This shows that the young cartilage cells migrate before their capsule is formed, for the only other contents of the cancellous spaces are dead connective-tissue cells and fat-cells. This remarkable migration of chondroblasts is undoubted, and sometimes cell groups with coalesced matrix occur amongst the dead contents. The trabeculæ in contact with the newly-formed penetrating cartilage are so scalloped in places that this must be due to the phagocytic action of the growing tissue. Only very rarely in the dead trabeculæ in the immediate neighbourhood of the overlying and the intruding cartilage, is a deeply-stained nucleus present in a few lacunæ, those around being empty. Such lacunæ are well formed, and there is no visible breach by which cells could have entered as extraneous. Nor are such nuclei in lacunæ near the edge of the trabeculæ, but lie fairly in the substance. It is clear, therefore, that no cell migration *through* the trabeculæ can be assumed.

Case 5.—Spec. 1936A, Museum, R.C.S.

It will have been noticed in the description of the microscopical appearances of Mr. Sargent's case that the bone-cells were all dead, and that in the Sir Everard Home specimen most were dead but a few were living. In the case now to be described a considerable number of the bone-corpuscles are living. The specimen was presented to the museum by Sir Frederick Treves; he removed it from the left knee of a labourer, age 28, who gave the following history :—

About four years previously he fell on his left knee whilst running, and it became very swollen and painful. After this his knee occasionally swelled, and was never quite so strong as the right. Three weeks previous to admission he sprained his knee by catching his foot against the edge of the pavement, and the joint became locked for about a minute, followed by swelling. After this he could often feel a loose body in the joint, which appeared above the patella on full flexion but disappeared on extension. On examination a loose body the size of a bean could easily be felt above, to the outer side of the patella. Sir Frederick Treves opened the joint by an incision above and to the outer side, and removed the body, which was quite free; the patient made a good recovery.

The specimen is of the 'classical' type, being smooth and cartilaginous on one surface, less regular on the other, and with rounded borders.

Microscopical appearances.—The smooth free surface is composed of normal articular cartilage, with calcified zone on the deep side. Next we see the dead cancellous bone, the spaces of which hold necrotic contents. But in the trabeculæ immediately beneath the calcified zone, a considerable number of bone-cells have deeply-stained nuclei; this applies only to the innermost parts, such as the zones immediately bounding the canals. There is a thick rounded cushion of small-celled cartilage at the edges; as usual this is continued over the opposite fractured surface. In this specimen the layer of reparative tissue is thin a short way beyond the edge. The intrusion of cartilage into the cancellous spaces is in places well seen, but not so marked as in *Cases* 2 and 3.

Case 6 (Spec. 722, St. Bart.'s Hosp.).

This case is of very great interest in that the bone-corpuscles are all living and have deeply-stained nuclei. It is to be particularly noted that it is the only case in this series in which there is no history of either direct or indirect injury. We shall refer to this more fully in the next section, where we summarize the conclusions to be drawn from the pathological pictures.

The patient from whom the specimen was obtained was a bargeman, age 27, who came under the care of Mr. Luther Holden at St. Bartholomew's Hospital, with the history that he had for the last three months suffered from all the symptoms of a loose body in the left knee and could often feel it himself. He was not aware of having injured his limb. Mr. Holden removed the body by Goyraud's subcutaneous operation. It was quite free, and the patient left the hospital cured.

From the absence of any traumatic history in this case it might be inferred that the detachment was due to a process of 'quiet necrosis'.

Case 7 (Spec. in the Bland-Sutton Inst. of Pathol., Middlesex Hosp.).

Fig. 362 shows a knee-joint from a man who was run over in Oxford Street, and died soon after admission to the hospital from shock following multiple injuries.

FIG. 362.
Loose body arising from fracture of patella.

It will be seen from the illustration that there has been a transverse fracture of the patella, which, however, is not a recent one, as union has taken place between the fragments. Occupying a pouch above and to the outer side of the trochlear surface of the femur is a loose body of the 'classical' type with smooth surfaces and rounded borders. Section of the body shows on one aspect a layer of normal articular cartilage with a subjacent portion of cancellous bone; the articular cartilage from the edges has spread over and completely covered in the deep or detached aspect of the bone. Near the middle of the inner border of the patella is an area from which the articular cartilage is missing, and beneath which is an irregular formation of callus. It is highly probable that the loose body was detached from this area at the time of the patellar fracture, and that subsequent proliferative changes caused it to assume its present shape and size.

3. *Loose bodies exhibiting a marked degree of proliferation of articular cartilage.*—

Case 1.—(Spec. 721, St. Bart.'s Hosp.). This is described as follows:—

Two portions of cartilage removed from the knee-joints of a lad 18 years old. They are almost exactly alike in form and size, each resembling such a piece of cartilage as might be obtained by removing that which covers the posterior surface of one of the condyles of the femur; and each —as such a piece would be—is smooth and polished on its convex and rough on its concave surface. There was an interval of about a year between the operations by which these bodies were removed from the joints. Patient recovered completely. Presented by Luther Holden.

Unfortunately I have been unable to discover the original notes of this case, so that it is quite impossible to say whether a history of injury was recorded.

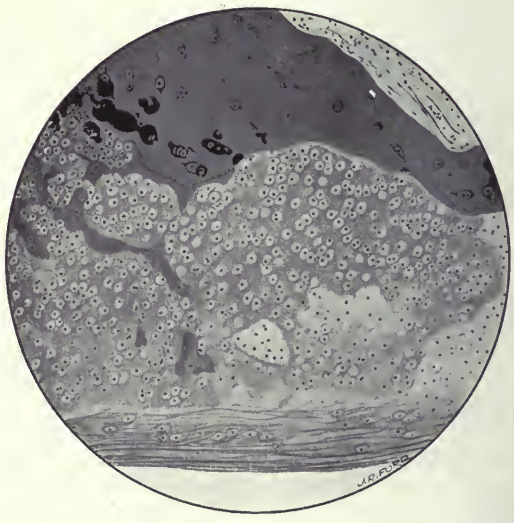


FIG. 363.—Microscopical section of *Case* 1. ($\frac{2}{3}$ *obj., reduced.*)

Microscopical appearances (*Fig.* 363).—Vertical section of whole substance shows typical articular cartilage in which the nuclei are well stained. There is no bone on the under surface —the detachment being just above or through the calcified zone. At either end there are well-marked areas of proliferated, small-celled cartilage, the free surface of which is flat-celled. The islands do not appear to have spread over the face of the fracture, for they occupy cavities in the original with excavated borders, there being no interval between the two. The matrix of the new cartilage is stained less deeply than the original.

At one end there is quite a deep inroad, the new tissue being of small-celled cartilage and connective tissue; some chondroid tissue also occurs in it (see next case). In the intruding cartilage and connective tissue there are apparently some capillaries, as if the piece was not immediately detached, or detached with some of the synovial membrane adherent.

Case 2.—(Spec. W.O. 1936F., R.C.S.). This specimen is of two loose bodies which were removed from a knee-joint. They are both oval and flattened, and the largest is $1\frac{1}{2}$ in. in its greatest diameter. The body has a corrugated surface, except over an area in the middle of the upper surface, which is smooth and somewhat depressed below the surrounding level. This smooth flat area represents the original articular surface, and the hypertrophy which has taken place in connection with the fragment almost obscures its source.

The bodies were removed from the knee-joint of a soldier who, while on active service, was often seized with sudden pain and locking of the joint while marching or running. The bodies could be easily felt in the suprapatellar pouch, and were successfully removed.

FIG. 364.—Loose body. Marked proliferative hyperplasia. (× 2.)

Microscopical appearances.—Fig. 364 shows the general appearance of the flat piece of detached articular cartilage, with the voluminous outgrowth it has furnished, which over-tops its edge and extends for a considerable thickness below. The structures of the original articular cartilage and its deeper large-celled layer are still recognizable, while beneath the latter can be seen the calcified layer. The new tissue in its general characters resembles that seen in Spec. 720B, St. Bart.'s Hosp., the tuberculated body arising in a synovial fringe to be described below. It consists of small-celled cartilage intermingled with strata of a more homogeneous material of an osteoid or chondroid character.

FIG. 365.—Microscopical section of left-hand upper border of preceding. ($\frac{2}{3}$ *obj., reduced.*)

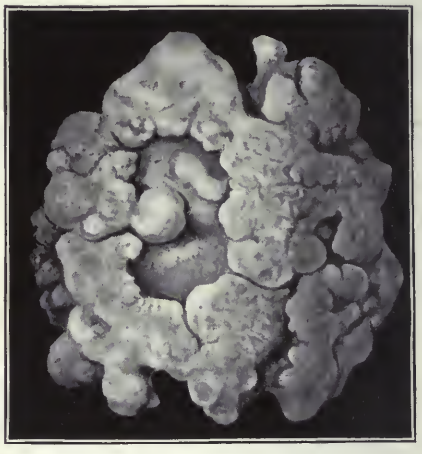
Fig. 365 shows a section of the elevation of new tissue on the right-hand side. It consists superficially of small-celled cartilage,

which bears a certain resemblance to the normal articular surface in that the more superficial cells have a flat disposition. More deeply the matrix has undergone calcification, and to the extreme right the new tissue takes the form of 'laminar osteoid tissue'. On the right-hand side, at the lowest part, is a bay filled with loose connective tissue, which is edged with a zone of proliferating cells, and in connection with which a laminar formation of osteoid tissue and cartilage has occurred.

4. *Loose bodies exhibiting a striking degree of proliferation.*—

The phenomena presented by this subdivision are truly remarkable; the cartilage cells proliferate with such exuberance that veritable cartilaginous tumours are formed. In the centre of the body can be seen the fragment of the articular surface originally detached.

Case 1.—(Spec. 1353.2, Museum, R.C.S.). Consists of two loose bodies of unusually large type which were removed from a knee-joint. They are both somewhat discoidal in form, and have a remarkably irregular, coral-like exterior, like some of the osteomata growing from the ends of the long bones; the larger has a chief diameter of $2\frac{1}{2}$ in. As seen in the section (*Fig.* 366), the smaller of the two bodies has in the centre a nucleus of



FIGS. 366, 367.—Loose bodies exhibiting marked degree of hyperplasia. (*Natural size.*)

dense osseous tissue, which is covered on one aspect by a layer of cartilage having the appearance of articular cartilage. Next succeeds a thick crust of cartilage which is obviously laminated in a circumferential manner. This external crust is traversed in places by fissures which have for the most part a radial arrangement. The general arrangement of this peripheral crust of cartilage suggests that seen in the last specimen (Spec. 1936F, Museum, R.C.S., *Fig.* 364), and also the pathological variety of loose body (Spec. 720B, St. Bart.'s Hosp.). The accompanying description states :—

> They were removed from the knee-joint of a labourer, age 25. The loose bodies lay in the cul-de-sac beneath the quadriceps extensors, and were very freely movable. The patient noticed a swelling in that situation after a fall on the knee five years previously. The margins of the femur were lipped, but there was no other evidence of osteo-arthritis.

Case 2 (Spec. 1931B, Museum, R.C.S., *Fig.* 367) is an equally remarkable example of very marked degree of proliferation of the articular cartilage. The short accompanying description states that :—

> It was removed by operation from the knee-joint of a man, age 55, who had been unable to flex his leg to the full extent for some months. A hard movable body could be felt in the supra-patellar recess of the joint previous to operation. There were evidences of rheumatoid arthritis in the knee.

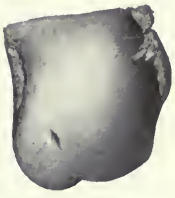
The body, which measures 2 in. in greatest diameter, is coarsely lobulated. On one of its surfaces there is a depressed area, the surface of which is comparatively smooth, and which is overlapped on either side by the surrounding lobules of cartilage. This smoother depressed area corresponds to the original surface of the detached portion of articular cartilage. A remarkable feature is that there is a fissure which traverses the newly-formed cartilage and also the included portion of cancellous bone, almost completely separating the body into two portions, the bond of union between which is a bridge formed by the original articular cartilage. We see, therefore, even in this marked example of the proliferative type, the same evidence of its traumatic origin that we have already described in previous cases.

5. *Feeble proliferation of articular cartilage.*

This is a rare condition, and is represented by but one example (*Fig.* 368) among the large number examined in the course of this research. This specimen is the one of 'quiet' necrosis described by Teale. It will be seen, as is so often the case, that the portion of the internal condyle from which the body was detached is that in the vicinity of the intercondylar notch.*

Fig. 368.—Teale's case, showing portion detached; upper border artificially removed.

Microscopical examination.—The cartilage cells towards the free surface stain feebly (possibly the result of imperfect fixation). More deeply the groups of cells and their nuclei are sharp and the nuclei fairly—not intensely—stained. On the free deep side, here and there are portions of large-celled cartilage. The remainder of the surface has the appearance of having been subjected to a good deal of friction, which has probably detached the remainder of the reparative tissue. At one spot below the large-celled deep cartilage is a small portion of bone—the articular bone.



We have already seen that when a portion of the articular surface is incompletely detached, or completely detached but remains *in situ*, its deep surface is subjected to a considerable degree of friction from the joint movements, and it is obvious in the above case that the reparative tissue has apparently been subjected to this form of attrition.

6. *Formation of new bone from the osteogenetic tissue in the cancellous spaces accompanying the formation of secondary adhesions, or incomplete detachment.*

In the cases that have been hitherto described, one very striking fact that forces itself upon the attention is that no case demonstrates new bone in process of formation. The cancellous spaces contain merely necrotic tissues, and no living and active osteogenetic cells. It will have been noted that these bodies were all quite free in the joint.

The examples of the subdivision we have now to consider were found at operation to

* I am indebted to Professor Stewart, of Leeds, for kindly lending me this specimen.

have acquired a secondary adhesion to the synovial membrane or to be incompletely detached. In this variety we find that the cancellous spaces still contain living contents and vessels, and that although many of the deeper bone-corpuscles, that is, those lying nearer to the articular cartilage, are dead, yet the more superficial cancellous spaces contain osteogenetic tissue actively engaged in laying down new bone upon the surface of the old. There can thus be little doubt that a loose body may, if attached secondarily to the synovial membrane or if incompletely detached, increase in size not only by proliferation of its cartilage cells but also by formation of new bone. Moreover it appears that, should secondary detachment of the loose body occur, the formation of bone ceases, whereas the cartilage continues its growth. This increase in bony substance of an attached loose body is important from the etiological point of view, as we shall see later, particularly in those cases where a loose body attached to a crucial ligament of the knee-joint occupies a pit on one or other femoral condyle. At first sight it would appear difficult to understand how such a body as that shown in *Fig.* 375 could be detached by traction of the ligament, unless we realize that the bone has probably continued its growth after incomplete detachment.

Case 1.—(Spec. S.D. 411, Lond. Hosp. Path. Inst.).

P. C., two months before admission to the London Hospital, sprained his knee in jumping from a ladder, and at the moment of the accident noticed a 'clicking' in the joint. He almost immediately noticed a loose body in the joint to the outer side of the patella. The accident was followed by slight swelling, but there was no pain and no locking. On admission, there was no swelling of the joint, and active and passive movements were painless. A loose body the size of a hazel-nut could be felt half an inch above the patella, and was revealed also by radiographic examination.

Mr. Lett removed the body, which was adherent to the synovial membrane of the suprapatellar pouch.

Microscopical examination.—This shows the cartilage to be normal living articular cartilage. Below the cartilage lies cancellous bone, of which the spaces are filled with normal living connective tissue and capillaries. The lacunæ of the bone, however, are empty, none of the bone-cells having survived. On the lower aspect of the bone the case is different, for here the free surface is formed by a highly vascular layer of loose connective tissue in which a new formation of osseous trabeculæ is in progress. These are surrounded by living osteoblasts and contain well-stained living bone-cells in their lacunæ; here and there osteoclasts lie against the living trabeculæ, and it can also be seen in places that the new bone is deposited on portions of dead original trabeculæ. The phenomenon is thus one of callus formation from connective tissue.

B.—Loose Bodies derived from Interarticular Fibrocartilages.

The question of injuries to the semilunar cartilages of the knee-joint is a large one, and is beyond the scope of the present article; I am, moreover, making it the subject of a further research. It will suffice to mention here that a portion of one of the semilunar cartilages—usually the anterior end of the internal semilunar—may occur as a rounded cartilaginous body, either attached by a pedicle of variable thickness to the remainder of the cartilage, or the pedicle may rupture and the body become quite free.

I have seen the internal semilunar cartilage completely detached from its site and with a secondary attachment round the periphery of the patella. Occasionally the posterior horn of one of the semilunars may form a pedunculated loose body in the joint. A good example of this is seen in Spec. 716C, St. Bart.'s Hosp. The posterior end of the internal semilunar has become hypertrophied and rounded, and made a groove for itself upon the articular surface of the external condyle.

C.—Loose Bodies formed by Detached Epiphyses not forming Portions of an Articulating Area.

(Spec. 714C, St. Bart.'s Hosp.). This loose body was removed by Sir Charles Gordon Watson from the elbow-joint of a boy, age 17, in whose joint it had been present for four years. There can be little doubt that the body is a detachment of the epiphysis of the external condyle of the humerus.

One surface of the loose body is convex and lowly nodulated, the other surface being concave. The section shows that there is a nucleus of bone in the centre, and that the convex aspect is covered by a thick layer of cartilage, which has also apparently spread over the concave detached surface. This cartilage has none of the characteristics of articular cartilage.

The history of the case is as follows :—

Four years previous to admission, when 13 years old, he fell upon the outer side of the left elbow. The accident was followed by pain, swelling, and stiffness of the elbow, and shooting pain down the radial side of the forearm. He suffered subsequently with recurrent attacks of painful locking, accompanied by swelling.

On examination at time of admission, it was found that the external condyle of the humerus was not in its natural position, being lower than normal. About one inch external to the olecranon is a hard prominent swelling, bony, and about ½ in. in diameter, and bony crepitus can be detected. This swelling is thought to be the displaced external condyle of the humerus. *Measurements :* Acromion to ext. condyle, left 12¾ in., right 12⅝ in. *Movements of elbow :* Flexion complete; some limitation of full extension. Supination incomplete and painful. Skiagram appears to show the external condyle of the humerus to be separated from the rest of the bone and displaced downwards.

Sir Charles Gordon Watson made an oblique incision over the most prominent part of the swelling, and found a loose body lying quite free in the joint cavity. It will be remembered that the centre of ossification appears in the cartilage of the external condyle at about the twelfth year and, coalescing with the centres for the trochlea and capitellum, forms with them an epiphysis which joins the shaft at about the seventeenth year.

GROUP III.

SYNOVIAL CHONDROMATA, LAMINATED AND NON-LAMINATED.

They may be divided into three classes : (*A*) *Single*, pedunculated or free ; (*B*) *Multiple*, pedunculated, free, or the two conditions combined ; and (*C*) *Diffuse*, usually associated with free bodies in the joint cavity.

The discovery by Kölliker of cartilage cells in the villi of the synovial membrane, and the observations of Rainey, have already been referred to in Section I. The loose bodies of the important group we are about to pass under review, although they may differ in structure and form, have the common characteristic that they have originated from the cartilage cells of the synovial villi, and are, therefore, true chondromata. It is impossible in the present state of our knowledge to assign a cause for this behaviour of the cartilage cells. In many cases there is a history of injury ; in others this is absent, and they often appear to occur in the course of chronic synovitis. Whether, however, the presence of the synovial chondromata caused the synovitis, or the latter was the exciting cause of the tumour formation, it is impossible in many instances to say.

A.—Synovial Chondromata. Single Variety. Pedunculated or Free.

Non-laminated.—The naked-eye characters of the single chondroma are shown in *Fig.* 369 (Spec. 1353.I, Museum, R.C.S.). It shows a lowly lobulated, oval chondroma, 3·5 cm. in chief diameter. In its centre there is a loculated cavity due to mucinoid degeneration ; it contains no bone. On the front of the specimen there is a central depression filled with fibrous tissue, of which tags project from the surface, apparently its site of attachment.

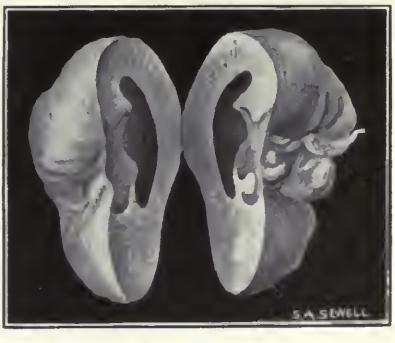


Fig. 369.—Non-laminated chondroma.

It was removed from the right knee-joint of a woman, age 42, who had for a long time been unable to kneel. The tumour was excised from the synovial membrane to the inner side of the patella, and was so attached to the outer aspect of the former that the knee-joint was not opened. Although the body lay in the subsynovial tissue without projecting into the joint proper, it may be assumed that it arose in connection with a minute cartilaginous nucleus in a synovial villus.

Laminated.—Except for the fact that they occur singly, the naked-eye and microscopical features of loose bodies of this type are very similar to the multiple laminated type to be reviewed below. As a rule, however, they grow to a greater size than the multiple loose bodies, and tend to occupy pouches or recesses of the synovial membrane, where they lie snugly. Owing to this characteristic, and also to their greater size, they but rarely cause the classical symptoms to which a loose body gives rise when it becomes caught between the articular surfaces. They are often discovered accidentally or on post-mortem examination. As we have noted in connection with the multiple type, one side of the loose body (usually that in contact with the synovial membrane) may be comparatively smooth and lowly convex, and may simulate somewhat closely the type to be described below derived from a detached portion of the articular surface, more particularly that of the femur. If a section of the body is examined, however, it will show the typical laminated appearance of a synovial development (*see Fig.* 370). This is an important point, as it seems clear that several of König's cases belong to this group. A history of antecedent injury may or may not be present.

Laminated.—The superficial and also the divided surface of a loose body, $\frac{3}{4}$ in. in its chief diameter, which was successfully removed from the knee-joint, and is preserved in the Pathological Museum of St. Thomas's Hospital. On both aspects the body was lowly tuberculated. It is extremely hard from calcification, which, as seen in the divided surface, has occurred in a laminated concentric manner.

The specimen was obtained from a man, age 40, who had received an injury to the knee and was admitted with a large effusion in the joint. No fracture was discovered by skiagraphy. When the swelling had subsided, a loose body was felt in the subcrural pouch. The body had caused no symptoms at any time, and there was no history of antecedent injury. There were no signs of osteo-arthritis.

B.—Synovial Chondromata. Multiple. Pedunculated, Free, or in Combination.

Laminated.—The size, shape, surface, and general characteristics of the multiple type are well shown in Spec. 720B, St. Bart.'s Hosp. (*not figured*).

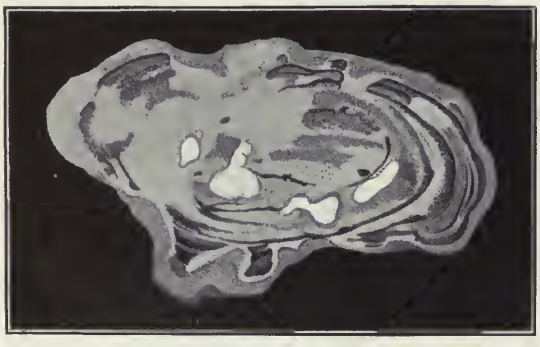


Fig. 370.—Section of laminated chondroma. (*Enlarged.*)

Fig. 371.—Abernethy's case. (*Nat. size.*)

It should be noticed that certain of these bodies are comparatively smooth on one side. This may be due to mutual pressure; but in many instances I have observed that these bodies occupy little pockets or pouches of the synovial membrane, and on lifting them from their bed it can be seen that the surface in contact with the latter is smooth, whereas the surface opposed to the joint cavity is more irregular, the result probably of the pressure exerted on the deep side. The description in the museum catalogue of this specimen is as follows:—

Thirty-five loose bodies from a knee-joint removed by operation. Four or five were in the main cavity of the joint; the remainder were lodged in a large bursal sac in the popliteal space.

Only one was attached by a long narrow pedicle; the rest were completely free. Patient was a young man, age 19 years. Six years before, the knee had been violently wrenched at football and the patient confined to his bed for a month. The bodies had been noticed in the joint for between two and three years, but the exact period of their development was uncertain. He made a good recovery from the operation, and when seen three months afterwards had free movement of the knee and was able to play tennis and to dance. Presented by H. Marsh.

There can be little doubt that these bodies originated as small pedunculated cartilaginous growths from the synovial membrane; that after a time they became detached, and that the majority of them found their way into the cyst in the popliteal space. The smallest of the bodies are seen still to have traces of their original pedicle, whereas in the larger (*Fig.* 370) no trace of a pedicle can be seen. It is clear from this that the bodies have continued to grow while quite free in the joint cavity.

Another interesting point in this case is that at operation only one cartilaginous body was seen to be attached to the synovial membrane.

Fig. 370 depicts the naked-eye appearance of a section of one of the loose bodies from Specimen 720B, and brings out well the concentric lamination which is one of their marked characteristics, and the cavities in the deeper part that have resulted from mucinoid degeneration of the cartilage; and *Fig.* 371 shows the divided surfaces of three out of fifteen loose bodies which were discovered post mortem by Abernethy in the hip-joint of an old woman. Although these are described as osteophytes, yet they are clearly of synovial origin.

Microscopical section (*Fig.* 372) shows a portion of the free surface of the same specimen as that represented enlarged four times in *Fig.* 370. The surface is covered with a fibrous membrane which is prolonged inwards as a bay, where the tissue is of more open texture. The deeper part of the fibrous tissue is very cellular, and is evidently the source of the more compact tissues produced on the deep aspect. Of the two deeper zones, that next the proliferating zone consists of a matrix coloured with the eosin, containing scattered cells without any recognizable capsules, but which may probably be regarded as immature cartilage, since a study of other sections shows that it is interchangeable and may merge into well-formed cartilage. It will be noticed that in the left-hand side of the bay referred to, an area of well-formed cartilage has been produced from the indifferent proliferating zone.

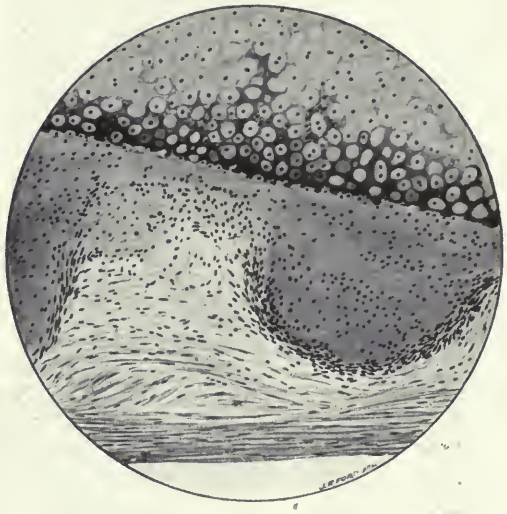


Fig. 372.—Microscopical section of portion of specimen shown in *Fig.* 370.

Above the immature zone there follows one of well-developed hyaline cartilage. Lastly, from the deepest part of the 'bay' a certain number of delicate fibres radiate with the tissues above like the proliferating fibres of bone. These in other sections are traceable in places into the matrix of the proper cartilage.

As shown by *Fig.* 370, the remainder of the body is seen to be made up of alternating zones of cartilaginoid tissue and cartilage, the latter in places having undergone calcification. The zones do not form complete circuits of mathematical accuracy. The lamination, as seen by the naked eye, is due to the areas of calcification. In the centre, mucinoid degeneration of the cartilage has taken place.

Non-laminated.—Case 1.—(Spec. 720A, St. Bart.'s Hosp., *Fig.* 373.)

Shows 415 loose cartilages removed from the right knee of a shoemaker, age 31, by Sir Thomas Smith. Most were lying quite free in the joint cavity, but a few of the bodies were attached by

slender pedicles to the inner surface of the synovial membrane. The patient stated that six years ago, without obvious cause, his knee became painful and swollen, and that the pain and swelling had steadily increased. The pain was more marked when the leg was extended.

On admission, the joint was seen to be generally enlarged and filled with small movable bodies, giving the sensation of shot in a bag.

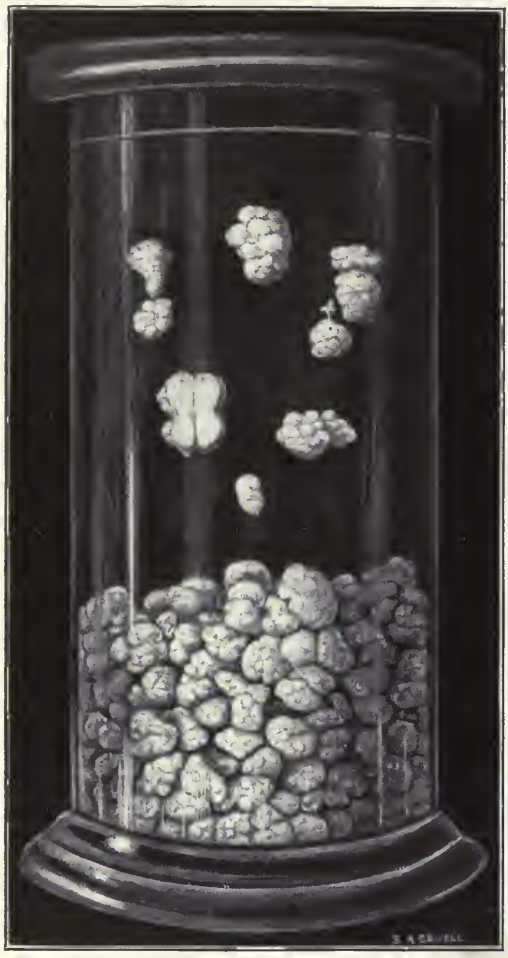


Fig. 373.—Multiple loose bodies. Spec. 720A, St. Bart's.

On examination, the smaller of these bodies are seen to consist of a single nodule of cartilage surrounded by connective tissue, and the larger consist of two or more nodules of cartilage held together by a loose network of connective tissue which also surrounds the periphery.

In the *Pathological Society*'s *Transactions*, London, vols. xlii and xlv, Mr. James Berry has described a very interesting case which clearly belongs to the subdivision we are considering.

Case 2.—*Non-laminated.*—The patient was an otherwise healthy young man, age 18. For about six months he had been subject to pain and swelling of the right knee, which prevented him from working; about two or three weeks before admission he had noticed movable bodies in his knee. There was no history of rheumatism or other illness, nor was there any history of trauma.

Mr. Berry removed the bodies, which showed the following features. All were white in colour and with a smooth and shining surface, and none had pedicles. The larger ones consisted of a number of small nodules of cartilage held together by an intervening network of very loose connective tissue. No epithelium could be seen on the surface. The smallest bodies consisted of a single nodule of cartilage surrounded by a layer of connective tissue. He was unable to express any definite opinion as to the origin of these bodies, but considered it doubtful whether they had been formed from the synovial fringes, because all the bodies were free, and the portion of synovial membrane that was seen at the time of operation was normal. He mentions, however, that at one spot the membrane was thickened and formed a lump, and suggested that it may have been from this spot that the loose bodies were derived.

After the operation the patient remained quite well for three years, but he then began to notice weakness and occasional swelling of the knee previously operated upon. After suffering for six months he came to the hospital again, and Mr. Berry removed no less than 1047 loose cartilaginous bodies. The bodies resembled those removed at the first operation, but were smaller. The lump that was felt in the suprapatellar pouch at the first operation could no longer be detected.

C.—Synovial Chondromata. Diffuse Variety.

Spec. 720C, St. Bart.'s Hosp., is a beautiful example of this variety, removed by Mr. Harrison Cripps from the left knee of a girl, age 14:—

Beyond measles when 4 years old she had had no previous illness, and there was no history of trauma. She first noticed pain in the left knee about two years before admission, and about one year ago she noticed some 'lumps' which appeared in various situations. At about this time also she experienced a 'clicking' sensation in the knee, which frequently gave way under her.

When admitted she was seen to be a healthy-looking girl. "The left knee looks a little swollen. A small swelling is felt just outside the patella when the leg is straight; on bending the knee to a right angle, this swelling becomes more distinct, and a second and smaller swelling is to be felt just above and inside the knee-cap. This is firmer than the former, and on straightening the knee again, it seems to slip away under the patella. Both swellings give a peculiar crunching feeling on being pressed, and there is some pain. Nothing is felt below and inside the patella, where patient states that sometimes a third swelling appears."

Mr. Cripps transfixed the loose body that was situated above and inside the patella. He then cut down upon it, thus opening the joint. A thickened synovial fringe was found, and in it were a number of cartilaginous nodules about the size of peas. Some of these nodules were lying free in the joint. One mass, about 1½ in. long and 1 in. diameter, was likewise found perfectly free. On passing the finger under the patella, Mr. Cripps found another mass of nodules lying in the outer part of the joint. A second incision was therefore made on the outer side of the patella, and the whole mass was removed. The patient made an uninterrupted recovery.

The specimen shows the mass of lobules of varying size growing from the synovial membrane. The mass in the centre is particularly prominent, and its surface is subdivided into secondary lobules. The lobules have a smooth surface and a pearly lustre. Portions of the synovial membrane can be seen at the margins of the specimen.

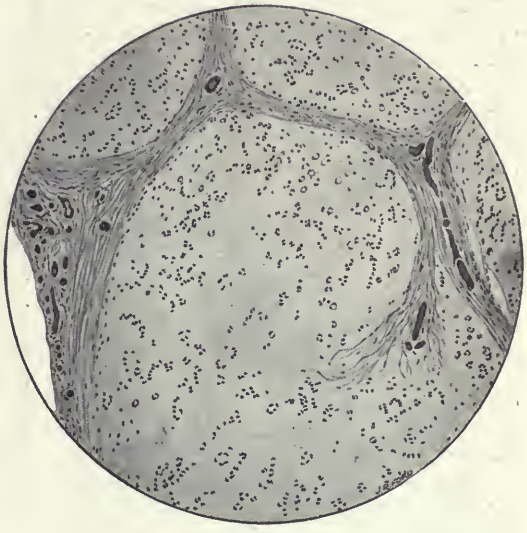


Fig. 374.—Microscopical section of diffuse chondroma. (⅔ *obj., reduced.*)

Fig. 374 shows the microscopic appearances. The tumour is composed of lobules of hyaline cartilage, between which are septa of fibrous tissue containing vessels. On the left is shown the fibrous capsule of the growth with its pertaining vessels.

Changes occurring in a joint from the long-continued presence of a loose body. (Spec. 1926, Museum, R.C.S.).

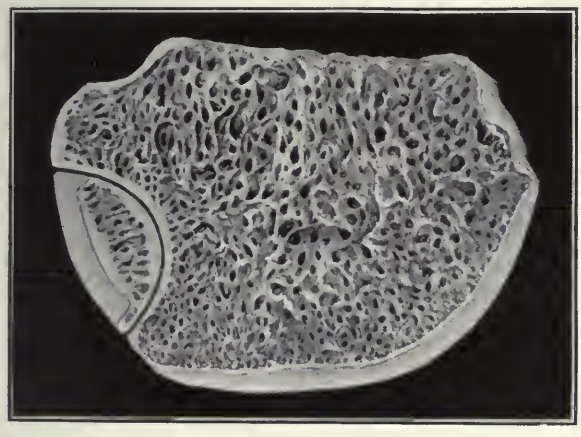


Fig. 375.—Loose body embedded in condyle.

Fig. 375 shows a large loose body of traumatic type produced by indirect violence such as violent traction exercised through the anterior crucial ligament, which was attached to the anterior crucial ligament and occupied a pit in the under surface of the external condyle of the femur. The section shows quite clearly its origin from the articular surface, although, according to the museum catalogue, it was considered to be one of synovial origin that "by friction and constant pressure had worn for itself a deep cavity in the condyle of the femur".

It is to be noticed that the condyle is practically denuded of its articular cartilage and the exposed surface of the bone is eburnated. One very interesting point is that the deep surface of the loose body and the bottom of the pit are also eburnated and marked by friction grooves. Some lipping of the articular margin is also

present. This loose body has almost certainly increased in size after detachment from new bone formation.

Occasionally loose bodies characteristic of osteo-arthritis may co-exist with a traumatic loose body.

III.—ETIOLOGY AND PATHOLOGICAL DEDUCTIONS.

In the present stage of our knowledge it is impossible to dogmatize upon the etiology of the more important loose bodies of *Group I*, i.e., the osteophytes, since it is bound up with the larger question of the etiology of osteo-arthritis.

Similarly, the etiology of *Group III*, the synovial chondromata, is bound up with the larger question of the etiology of tumours. Although it is probable that the cartilage-cells in the synovial villi from which they originate are, as Professor Shattock pointed out, derived from the primitive cartilaginous bar which in the developing embryo becomes cleft to form the knee-joint, the periphery remains to become the capsule and synovial membrane. Trauma, however, undoubtedly may be a contributory factor. *Fig.* 376 shows an *x*-ray of one of my cases, where the patient was struck a severe blow just above the patella, a year previous to the *x*-ray examination. This section will therefore deal principally with the etiology of the type of loose body derived from the articular surface (*Group II, Class* 1).

Fig. 376.—Skiagram; multiple chondromata.

1. Deductions to be drawn upon the Etiology of Loose Bodies of Group II (Class 1, including Classical Type), from the Pathological and Clinical Data, with an account of some Experimental Observations.

A.—Deductions from the Pathological Data.—

1. When composed of articular cartilage only, the latter, so far from being necrosed, is perfectly healthy (except perhaps in the Teale case) and in many cases actually proliferates. Anything more unlike a sequestrum in its behaviour it would be impossible to imagine.

2. In the large series examined there were no signs of any pathological process such as pitting due to phagocytic action such as a sequestrum shows, and no layer of granulation tissue or fibrous tissue on the deep surface. On the other hand, the deep surface had in many cases all the appearances of a fractured surface. The series examined has included many of the specimens from pathological museums labelled 'quiet necrosis'.

3. In those cases where it has been possible to ascertain whence they have arisen, they are found to arise from those parts of the joint surfaces most exposed to injury.

4. They often present to the naked eye the form of grooves on the articular surface associated with fracture of the subjacent bone of traumatic origin.

5. Although many of the bone-corpuscles are dead in cases where the loose body consists of bone in addition to cartilage, yet it is clear that their death has taken place *after* and not before detachment, and this fact cannot therefore be adduced in favour of some pathological process such as 'quiet necrosis'. In the experiments to be described below, identical appearances are seen, and here there can be no question that the death of the bone-corpuscles must have taken place *after* detachment of the loose body. We see exactly

the same behaviour of the bone-corpuscles in experimental bone-grafting; for Hey Groves, Axhausen, and others have shown that the majority of the bone-corpuscles in a bone-graft die. We shall refer to this again later.

Moreover, as previously mentioned, in the only case in the whole series where there was no history of injury, and where we should expect to see marked evidence of some pathological process such as 'quiet necrosis', we find that *the bone-corpuscles are all living*

To sum up the pathological data: the naked-eye and microscopical features of this group of loose bodies demonstrate that they are detached by trauma.

***B.*—Deductions from the Clinical Data.—**

1. *The Traumatic Factor.*—Martens, who made an analysis of König's cases, found that out of a series of 54 cases there were 20 with a definite history of antecedent trauma, and 34 where this was absent or of an insignificant nature. But, as we have shown above, all figures not based upon microscopic examination of every case are fallacious owing to the way in which the solitary osteo-arthritic loose body may simulate the traumatic type.

In my own series of cases quoted above, all of which were examined microscopically, there were 16 cases—of these, 3 cases had no accompanying history and may be discarded for statistical purposes, leaving 13 with an accompanying history. In 12 out of the 13 there was a definite history of antecedent trauma, 6 being cases of direct and 6 of indirect injury.

FIG. 377.—Wedge-shaped fragment detached by traction from external condyle in cadaver.

In only one case was there no history of antecedent injury, *yet in this case not only the cartilage cells but all the bone corpuscles were perfectly healthy, and there was no sign whatsoever of any morbid process.* The clinical evidence from this source strongly supports, therefore, the traumatic origin of this group.

To further investigate this point I searched through the surgical records of St. Bartholomew's Hospital, and found that in the last seventeen years there have been 20 cases of solitary loose body operated upon. These were not all examined microscopically, and therefore almost certainly include a certain number of the solitary pathological variety; yet in no less than 80 per cent of these cases was there a definite history present. If we were able to exclude the pathological type in this series it is obvious that the percentage would be still greater. Surely it is reasonable to assume that in the small percentage of cases remaining, in which no history of injury is present, *leading questions were asked as to a direct injury, and the possibility of indirect was overlooked or forgotten.*

But it may be asked: How can indirect injury lead to a detachment of a portion of the articular surface? I believe that in many cases they are pulled off by the crucial ligaments, and it is certainly remarkable that these bodies are commonly derived from the area near the attachment of one or other crucial ligament. *Fig.* 377 shows the knee-joint of a full-term fœtus in which, by fully flexing the knee and then internally rotating, a very large piece of the inner portion of the external condyle of the femur has been wrenched off.

Then another and, I believe, not infrequent detachment by indirect injury is produced by violent tension upon the posterior ligament of the knee-joint, which it will be remembered is attached immediately adjacent to the articular margin and is powerfully reinforced by the tendons of the gastrocnemius and semimembranosus muscles.

Sir Anthony Bowlby has drawn attention to a specimen in St. Bartholomew's Museum, consisting of two portions of cartilage which were removed by operation from the knee-joints of a boy, age 18, by Holden, and each exactly resembles the cartilage over

the posterior aspect of the condyles. There was a year's interval between the two operations.

2. *The Interval occasionally occurring between an Injury and the onset of the Classical Symptoms of a Loose Body.*—Supporters of the theories of 'quiet necrosis' or 'osteochondritis dissecans' lay considerable stress upon this interval. Yet this interval can be satisfactorily explained if we bear in mind that the classical symptoms are due to the loose body being caught between the articular surfaces, this giving rise to sudden attacks of pain or even locking. If the loose body has become attached to the synovial membrane in such a position that it is unable to wander freely about the joint or get between the articular surfaces, or if it has not been completely detached and occupies a pit in the articular surface, then *the classical symptoms may not arise.* Should it eventually become completely free, more definite symptoms may arise.

The clinical evidence would therefore appear to favour strongly the traumatic origin of loose bodies of the 'classical' type.

C.—**Deductions from Experimental Observations.**—

1. *Experiments upon the Cadaver.*—Although it is scarcely logical to argue from the dead to the living, yet I have been able, exercising quite moderate violence, to detach both completely and incompletely portions of the articular surface of the femoral condyles in the cadaver. I found that a blow by a hammer upon the lateral margin of the condyle (*Fig.* 378) produced a detachment of a portion of articular cartilage, this detachment usually occurring through the brittle calcified zone. If, however, the surface of the condyle was struck, a much greater degree of violence was necessary to detach a portion of the articular surface. I have already referred to my artificial production of loose bodies by tension upon the crucial ligaments.

FIG. 378.—Articular cartilage detached by direct violence in cadaver.

2. *Experiments upon Animals.*—These yield results of great interest. I describe here a typical experiment upon the knee-joint of a rabbit, where a small portion of the articular end of the femur was detached by a chisel after opening the joint, the artificially-produced loose body being subsequently examined.

1*st Operation.*—The right knee-joint of a rabbit was opened from the inner side. A small portion of articular cartilage, with a portion of the subjacent bone, was chiselled off —the portion involving the inner lip of the trochlear surface of the femur and a small portion of the inner condyle of the femur. The portion was completely detached and pushed up into the suprapatellar recess of the joint. The joint was then closed, the incisions in the capsule and skin being separately sutured with catgut and a collodion dressing applied. 2*nd Operation.*—The joint was reopened five weeks later, and the loose body found to have acquired a secondary attachment to the synovial membrane of the suprapatellar pouch. This attachment was divided with scissors and the loose body removed.

Microscopical examination revealed characters almost identical with those seen in *Case* 1, p. 510, and the general features resemble a loose body of the classical type in that the majority of the cartilage cells are perfectly healthy but many of the bone-corpuscles are dead. But the latter must have died *after* detachment; therefore it seems reasonable to assume that the bone-corpuscles in the classical type of loose body have also died after the detachment by trauma, and that their death is not due to any morbid pathological process.

The experimental data thus, in addition to the pathological and clinical data, are consistent with the traumatic origin of the classical type of loose body occurring in joints.

Short Review of the Principal Literature dealing with the Structure and Nutrition of Articular Cartilage and of the Behaviour of Transplanted Cartilage.

1. Joseph Toynbee, working at the Royal College of Surgeons of England, in 1841, described the capillary loops lying immediately beneath the layer of articular cartilage, and concluded that from this subarticular plexus exuded the lymph from which the cartilage derived its nourishment.
"The Non-vascularity of Certain Animal Tissues", *Phil. Trans.*, 1841, part 2, 159.

2. Peter Redfern, while Professor of Anatomy and Physiology at Aberdeen in 1851, published his researches. He performed no less than 90 operations upon animals to investigate the healing of cartilage. His conclusions were that there was no reproduction of cartilage.
A Normal Nutrition in Human Articular Cartilage, 1850, Edinburgh.
"On the Healing of Wounds in Articular Cartilage", *Month. Jour. Med. Sci.*, 1851, xiii, 201.

3. Alexander Ogston, in the year 1875, came to the conclusion that the middle zone of the articular cartilage was reproductive in character, and that it made good the constant attrition of the superficial layers and the losses occasioned in the deepest layer by the inroads of adjacent osteoblasts.
Jour. Anat. and Physiol., 1876, x, 49; 1878, xii, 503.

4. Ollier found that perichondrium alone or cartilage alone could not be successfully transplanted from one animal to another, but that cartilage transplanted *with* its perichondrium lived. However, there was no reproduction of cartilage substance.
Traité expérimental et clinique de la régénération des os, 1868, Paris.

5. Bert transplanted portions of the spinal column of rats, and found that the cartilaginous elements of the graft increased in size.
Recherches expérimentales de la vitalité propre des tissus animaux, 1866, Paris.

6. S. G. Shattock transplanted fœtal rabbit-bones beneath the skin of the doe, and obtained active and marked proliferation of the epiphyseal cartilage of the ends of the bones.
Proc. Roy. Soc. Med. (Path. Sect.), iii, 127, Shattock, Seligmann, and Dudgeon.

Grafting of Joint-ends.—Lexer records some remarkable results from this procedure, which had previously been experimentally performed by Axhausen upon animals. Lexer resected the head of the tibia on account of a myeloid tumour, and replaced it by the corresponding part from an amputated limb. The result was functionally perfect. He also resected a tuberculous joint in a girl of 18, and substituted for it the knee-joint from a recently amputated limb. The result was again successful.

Kuttner's cases of joint-transplantation are of particular interest, as in two of them the joints were subsequently examined some time afterwards and microscopical examination showed survival of the *articular cartilage*; but the absence of cells from the compact bone showed it to be necrosed.

Axhausen's animal experiments showed practically the same thing, viz., that the articular cartilage of the transplanted joint-end lived, whereas most of the cells of the compact bone were necrosed, a few only being living.

Arch. f. klin. Chir., 1909, xc, 263; *Ibid*, 1912, xcix, 1; *Verhandl. d. deuts. Ges. f. Chir.*, 1913, xlii, 353.

2. Deductions upon Cartilage Vitality, Growth, and Repair, and upon the Nutrition of Articular Cartilage, to be Drawn from a Study of the Pathological Data.

A.—**Vitality of Articular Cartilage.**—The first fact of interest to be noted is that the behaviour of the cartilage cells demonstrates that their vitality has been considerably underestimated. A loose body of the traumatic type when free in a joint is essentially an autoplastic graft surrounded by the synovial fluid, and when the loose body is composed of both cartilage and bone we have an excellent opportunity of observing and comparing the behaviour of these two substances. One then observes that the cartilage cells retain their vitality in almost every case and after a time actively proliferate, but that the majority of the bone-corpuscles die, as do also the contents of the bony spaces. As we have mentioned previously, we see the same difference in behaviour between cartilage cells and bone-corpuscles after transplantation of joint-ends.

B.—**Growth and Repair of Articular Cartilage.**—Present-day teaching is largely based upon the experiments of Redfern, performed in pre-antiseptic days. The general conclusions drawn from these experiments was that cartilage cells were destitute of the powers of repair. Yet there can be no doubt that the phenomena described above refute the conclusions arrived at by the earlier experiments. At present I am performing a series of experiments upon animals in order further to investigate growth and repair in cartilage, and which will be made the subject of a further communication.

C.—**Growth and Repair of Cartilage other than Articular.**—Professor Shattock has kindly allowed me to reproduce in this connection one of his hitherto unpublished

observations. *Fig.* 379 shows the reparative production of new cartilage from the cut edges of one of the tracheal rings which was divided six years previously in a tracheotomy. The opposite edge of the cut surface of the same ring showed precisely the same repair. The actual interval between the two is filled with dense fibrous tissue. The specimen was obtained from a boy, age 15, upon whom tracheotomy had been performed six years previously. This specimen shows with almost startling clearness *that cartilage cells are capable of growth and repair.*

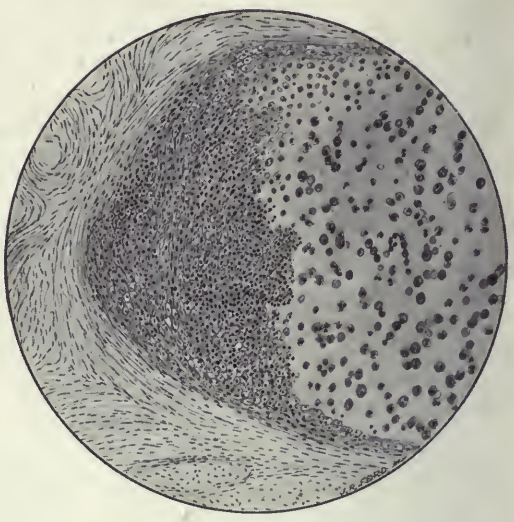


FIG. 379.—Budding cartilage from end of tracheal ring divided in tracheotomy.

D.—**Nutrition of Articular Cartilage.**—Dr. Strangeways ("Observations on the Nutrition of Articular Cartilage", *Brit. Med. Jour.*, 1920, May 15), who has also observed the cartilage proliferation in loose bodies, argues from this that the articular cartilage normally derives the greater part of its nourishment from the synovial fluid. Although it is clear that a loose body *may* derive its nutriment from the synovial fluid, yet I do not think this proves that it normally derives its nutrition in this way.

We must not ignore two other possible sources :—

a. Plasma exuded from capillaries lying in the cancellous spaces abutting on the calcified layer of the articular cartilage.

b. Plasma exuded from the plexus of vessels lying beneath the synovial membrane at the margin of the articular cartilage (circulus articuli vasculosus).

When, therefore, a portion of articular cartilage is detached, forming a loose body, it may merely be that it changes its source of plasma from the subarticular vessels to that of the synovial fluid. Its continued vitality or growth in the latter does not seem, therefore, a conclusive argument that this is its normal source of nutrition. This subject requires further investigation, and has a very important bearing upon the pathology of osteo-arthritis.

Application of these facts to Cartilage-grafting.—Owing to the inherent vitality of cartilage cells, it is clear that the use of cartilaginous grafts in surgery is based upon sound principles. Morestin has done excellent work in this connection, and has used autogenous grafts of costal cartilage to repair defects in the cranial wall and facial skeleton.

3. DEDUCTIONS TO BE DRAWN FROM A STUDY OF THE 'CLASSICAL' TYPE OF LOOSE BODY UPON THE BEHAVIOUR OF THE BONE-CORPUSCLES IN AN AUTOGENOUS GRAFT.

From a study of the pathological appearances in the cases that we have described of loose bodies of bone and cartilage *quite free* in the joint, it is clear that, except in one case, the majority of the bone-corpuscles were dead, as exemplified by the lacunæ no longer holding stainable cells, and by the fact that the spaces contain nothing that stained and were, in fact, empty. Furthermore, in *not a single case was there any evidence of proliferation of osteoblasts with formation of new bone.*

Yet we see a striking difference on examining those bodies of traumatic origin and containing bone which have acquired an early adhesion to the synovial membrane. For in these cases fresh capillaries can be seen to have penetrated the cancellous spaces, and active proliferation of osteoblasts with formation of new bone is taking place. Exactly

the same thing can be observed in the experimental production of loose bodies which show secondary attachment to the synovial membrane with active proliferation of bone-cells.

These observations therefore support Hey Groves' contention that the osteogenic cells in the Haversian canals and cancellous spaces of an autogenous bone-graft actively proliferate only if the graft becomes to some extent vascularized by the ingrowth of capillaries from surrounding parts.

As therefore the vascular supply appears to be of such paramount importance in the osteogenetic function of the bone-graft, it would appear to be advantageous to retain the periosteum in order to enable the graft to establish its vascular connections as rapidly as possible.

And in grafting cartilage the indication would appear to be to retain the perichondrium in order to supply an additional aid to any further production of the cartilage.

IV.—DIAGNOSIS AND TREATMENT.

Diagnosis of the Traumatic Loose Bodies.—Considerations of space will not permit the enumeration of a number of case histories, and compel me to summarize my conclusions from these. If we bear in mind the pathological and experimental data, it will help us to understand the often extremely puzzling symptoms to which a loose body may give rise. We have seen that a portion of the articular surface may in the first place be incompletely detached, in which case it may lie snugly in place, flush with the articular surface; or, on the other hand, it may be capable of considerable movement. Secondly, the detached portion may be quite free in the joint. Thirdly, it may acquire a secondary adhesion to the synovial membrane.

Now the classical symptoms of a loose body, which are sudden attacks of severe pain, often followed by swelling or momentary locking, are due either to the body becoming suddenly and momentarily nipped between the articular surfaces or between the capsule and the joint ends. These symptoms cannot arise when either the body is firmly attached to the synovial membrane at some point where it cannot get between the articular surfaces, or when it is incompletely detached and lies snugly *in situ*. Bearing these facts in mind, it is possible to describe three different groups into which the symptoms fall, and place side by side with the symptoms the corresponding pathological picture.

Group 1.—A portion of articular surface is completely detached; wanders freely about joint; and after an interval becomes secondarily attached to synovial membrane.

An injury, direct or indirect, is followed almost immediately by classical symptoms; and after an interval these disappear.

Group 2.—The portion of articular surface is completely detached, becomes almost immediately adherent to synovial membrane; but after an interval it becomes detached therefrom.

An injury, direct or indirect, is followed by freedom from classical symptoms; but after an interval the latter symptoms arise.

Group 3.—A portion of the articular surface is *gradually* detached; at length it becomes freely movable or completely detached.

Here the process of gradual detachment is accompanied by attacks of pain and swelling, often increasing in severity, and these are followed at last by the classical symptoms. These again may disappear when the body becomes secondarily attached to the synovial membrane.

Symptomatology of the Pathological Varieties.—The symptoms to which the solitary osteo-arthritic body or the solitary synovial chondroma may give rise are almost identical with those we have already described.

When, however, multiple synovial chondromata are present, we find that, as a rule, owing to their number and smaller size, the bodies are apt to become caught between the joint surfaces much more frequently. This occurrence is, however, not associated with such pain or inconvenience to the patient as in the case of the solitary varieties.

Treatment.—The treatment in the case of the traumatic loose bodies and of the synovial chondromata is, in most cases, removal.

In the former group, provided the aseptic technique is beyond reproach, the results are naturally good, since they usually occur in a joint that is otherwise normal. However, if the traumatic loose body has been allowed to remain in the joint long enough to cause a chronic villous synovitis or commencing osteo-arthritis, although we may cure the sudden attacks of pain due to the body becoming impinged between the articular surfaces, yet the operation may be followed by pain, swelling, and feeling of weakness in the joint due to the superimposed condition. This forms one argument for early operation, another being that the presence in a joint of a loose body is a source of danger, as when a loose body suddenly becomes impinged between the articular surfaces of the knee when crossing a crowded street. These propensities of loose bodies also interfere with athletic pursuits.

FIG. 380.—Skiagram showing loose body of classical form, including bone.

In the case of the pathological loose bodies in osteo-arthritis, an operation is usually indicated in young or middle-aged people when troublesome locking occurs, and when the joint is not seriously disorganized. The operation has naturally no effect on the course of the disease, and is of a palliative nature.

The results of operation in the synovial chondromata are also good provided the condition is not progressive, for the process may end as suddenly and mysteriously as it commences. If we are lucky enough to operate when the process has come to an end, the result is generally good; if not, further operations may be required.

I saw recently a man who, fifteen years ago, while in India, had over 700 cartilaginous loose bodies removed from his left knee. On examination his knee appeared perfectly normal, and it caused him no trouble whatsoever.

Any operation for removal of a loose body or bodies should be preceded by an *x*-ray examination taken in two planes, from which we may learn how and where to open the joint. An *x*-ray is only helpful when the loose body contains bone. *Fig.* 380 shows a skiagram of one of my own specimens that contained bone which, however, was of new formation, as a large number of previous *x*-rays showed nothing, although definite signs were present. In every case our incision through the skin and capsule should be liberal, in order to explore the joint as thoroughly as possible. To transfix and remove the loose body through a button-hole incision is an unscientific procedure reminiscent of pre-antiseptic days, for unless we explore the joint we are very apt to overlook other loose bodies or co-existent conditions which may give rise to a recurrence of the symptoms.

It is my pleasant duty to express my indebtedness to Professor S. G. Shattock, who has throughout the research given me the benefit of his help, advice, and criticism, and has also kindly placed at my disposal the pathological collections at the Royal College of Surgeons and at St. Thomas's Hospital. To the Medical Research Council, under whose auspices the research has been conducted, my thanks are also due.

I am also indebted to Dr. T. H. G. Shore, Curator of the Pathological Museum of St.

Bartholomew's Hospital, to Dr. H. M. Turnbull, of the London Hospital Pathological Institute, and to the curators of many other London and provincial pathological museums, for the loan of specimens. To the Council of the Royal College of Surgeons and to Professor Keith I am indebted for laboratory accommodation at the College; and to many kind friends at the Ministry of Pensions my thanks are due for the facilities provided me for observation of joint cases.

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DOWNWARD DISLOCATION OF THE PATELLA.

By H. RUTHERFURD, Glasgow.

In the last twenty years three cases of this injury have come under my care.

1. The first of these was reported in the *Lancet* of June 22, 1901, along with a case in the reverse direction by Dr. David Newman. A young man, age 18, had struck his knee against a bogey or truck which was standing in his way, and was thrown down by the violence of the impact. It is to be noted that this does not seem to indicate a high degree of violence. On examination, the opinion was formed that the edge presenting was the lower border, and that the upper border was engaged between the femur and the tibia. This was confirmed by the skiagraph, after failure to reduce by manipulation. A horse-shoe flap was turned up as in operating for fractured patella, and a hook having been passed through the capsule the bone was pulled out and into place over the condyles of the femur. Recovery with good knee.

Owing to the reflection of this flap I was able to see that both patellar ligament and quadriceps tendon were intact.

2. Francis C., age 42, admitted to Glasgow Royal Infirmary on July 9, 1920. Had been knocked off a ladder from a height of about 10 feet, landing on his right knee. There was a punctured and contused wound over the right patella, and that bone was first thought to be the subject of a comminuted fracture. A few days later it was noted : " The patella is fixed, and forms an unusual prominence between the femur and the tibia. The skiagraph shows what has happened : the upper edge of the patella, with apparently some part of its anterior surface, has been torn away and remains with the quadriceps tendon ; the bone itself has been turned vertically through a right angle, being engaged between the femur and the tibia ". Again a flap was turned up ; the capsule was found untorn ; an incision was made on the inner side, and the patella was levered into position. A skiagraph showed good contact between the shell-like fragment and the main portion which had been dislocated. Result : a useful knee, with only a slight restriction of movement. The patient declined further treatment.

3. Donald A., age 7. Admitted Nov. 18, 1920, having been knocked down by a tram-way car, sustaining multiple injuries to head and limbs. There was much swelling of the left knee, and there was thought at first to be a fracture of the patella. A skiagraph, however, showed simple dislocation as in *Case* 1. No dissection was done. The reduction was effected by an elevator through a cut to the side of the patella. Good result. The patient was examined six weeks later, and all movements were normal.

As to the occurrence of fractures of the patella in such a young subject, Reichel (Bergmann, Bruns, and Mikulicz) says : " Below the age of 20, fractures of the patella have been observed very rarely, almost never in children under 10." According to Arthur Thompson in Cunningham's *Anatomy*, the centre for ossification appears about the third year and spreads more particularly over its deeper surface. Two centres vertically disposed have also been described. Ossification is usually completed by the age of puberty.

As regards the dislocation downwards, the same author, Reichel, is able to quote only four cases. What he regards as the most characteristic case, inasmuch as the extension apparatus at the knee was not interrupted, was complicated by tearing of the cruciate and external lateral ligaments of the knee. In this case also it is to be noted that the articular surface of the patella looked upwards ; that is to say, the lower edge was engaged between the bones. In this respect it agrees with the case reported by Dr. Newman along with my first one in the *Lancet*. The other three cases quoted by Reichel were complicated by tearing through of the quadriceps tendon at its insertion.

FIG. 381.—*Case* 2. Before reduction.

FIG. 382.—*Case* 2. After reduction.

Stimson (*Fractures and Dislocations*, 1899, p. 772) has expressed his opinion thus: "Dislocations (of the patella) upwards and downwards should not, I think, have a place in the classification, since they are the secondary results of other lesions, rupture of the ligamentum patellæ or the tendon of the quadriceps, which are to be deemed the principal or controlling ones". The same view is set forth by Stephen Smith in his edition of Hamilton on *Fractures*

FIG. 383.—*Case* 3. Showing the dislocation.

FIG. 384.—*Case* 3. After reduction.

and Dislocations and by Berger (art. 'Rotule', *Dictionnaire Encyclop. des Sciences Médicales*, 1877), who quotes Malgaigne, and before him Pétit, as having enunciated the doctrine. Both in causation and in result a tearing across of the tendon of the quadriceps is distinguishable from a partial tearing out of the patella from the deep surface of that tendon, and this is what, in the cases here put on record, must be supposed to have taken place.

The tearing away of a bony shell with the tendon in the second case, and the integrity of the more or less cartilaginous patella in the child of 7, are not difficult to understand, if we are right in supposing that the displacement is caused by a blow on the patella with the knee flexed. The further flexion is carried, the smaller the surface in contact with the condyles; let the blow be directed downwards as well as backwards, and it will be easy for the upper edge of the patella to slip under the condyles, or, in the case of the young child, to squeeze through between them.

CARCINOMA OF THE BREAST.

By G. W. NICHOLSON, London.

Sir G. Lenthal Cheatle has published two admirable papers in Nos. 30 and 31 of this Journal on the subject of cancer of the breast. I am in the most cordial agreement with all his chief arguments and conclusions. As they were written primarily from the point of view of a surgeon, and are of equal, or even greater, interest to the pathologist, I venture to make a few comments on them from the point of view of the latter.

His three principal conclusions are the following : —

1. That cysts are the result of epithelial proliferation, and that most of them are better described as fusiform dilatations of the ducts.

2. That carcinoma of the breast arises, much more commonly than is generally supposed, in the epithelium of ducts.

3. That cysts of the breast are dangerous.

Cheatle has very clearly, in my opinion, demonstrated the truth that cyst formation progresses hand in hand with epithelial proliferation, of which it is frequently a result. This does not apply to the breast alone, but is equally true of papillomata of granular kidneys, to mention but one example. He has done much to reconcile me to the teaching of the French school, that cystic disease of the breast is a new growth, a cystoma.

I am prepared to agree with Cheatle when he maintains that all, or almost all, carcinomata of the breast are of duct origin. Only in a minority, although a fairly large one, can this be proved with more or less certainty. Unless I am much mistaken, this was the view insisted on many years ago by the late Professor Kanthack, who, however, never wrote on the subject to my knowledge. But the thing is obvious to anyone who uses his eyes in addition to the microscope. The spherical, rather pale cells with distinct nuclei that make up the bulk of carcinomata of the breast, are identical with those found in ducts whose epithelium has proliferated. They are not commonly met with in the latter structures, it is true, but I have seen them on several occasions. Again, they are to be found in many intracystic growths of undoubted duct origin, side by side with the characteristic tall columnar cells. Yet again, in many instances of ordinary 'carcinoma simplex' the large 'laciform' masses can be found in sections, and I have, on several occasions, traced the featureless infiltrating spheroidal cells to them. As a pathologist, I must protest against the use of the term 'metaplasia' in describing the change from the cylindrical to the spherical form. It is used to describe a very different set of phenomena. Nor can I quite agree with the idea that this change is of the nature of a reversion to a lower type. It is simply one of form, and expresses an accommodation to differences in environment. But these are very minor points.

I fully appreciate the difficulty of determining whether the delicate cylindrical cells arise from ducts or from acini, and have often puzzled over this point myself.

But, leaving practical experience aside for the moment, it is to be expected on purely theoretical grounds that a carcinoma should originate in the epithelium of a duct. It is less differentiated than that of secreting acini, and therefore better able to proliferate. Pathologists have sadly neglected the importance of Schaper and Cohen's[1] great paper, in which they show that epithelial organs contain growth centres which are less differentiated than the rest of the epithelium, supply the material for growth during the later stages of development, regenerate the normal wear and tear of the tissue, and respond to pathological stimulation by active proliferation. In compound secreting glands these areas are represented by the junctional ducts between the secreting acini and large ducts. It is here, in my opinion, that cancer of the breast actually begins in the majority of cases.

It is because it begins here that it is so difficult to decide, by the form of the cells, whether they be derived from acini or ducts. Next in frequency as sites of cancer formation come the larger ducts, and last of all the secreting acini, since it requires a much more profound degree of dedifferentiation (a process which, as I believe, does occur) to enable them to reassume the function of growth.

One of the great merits of Cheatle's papers, from the point of view of the pathologist, is to have adduced strong evidence that, in the breast, the growth centres of Schaper and Cohen are situated in the ducts. The second and greatest merit of the papers lies in the fact that they have given one more, and that a severe, blow to Cohnheim's theory of the importance of 'embryonic' displaced cells in tumour formation. I must confess to being one of those who, after contemplation of the photograph,[2] doubt the malignancy of the breast illustrated in *Fig.* 99, although I agree with the author in that, had the case passed through my hands, the surgeon would have been advised to remove the breast if he had not already done so. This difference of opinion is therefore of no vital importance, and I only mention it to emphasize the point I desire to make. In the breast can we trace, better than in almost any other organ, all the stages, from simple hyperplasia of epithelium through excessive hyperplasia to blastomatous proliferation. It is the second of these stages that I believe *Fig.* 99 to represent, a stage which in itself is not as yet definitely carcinomatous, but which we have learnt to regard with grave suspicion.

I am far from wishing to uphold the view so obnoxious to Ribbert and others that cancer spreads by a process of infection, and that a carcinoma, once it is definitely established, ever grows by other means than by division of its own cells. But I have insisted for years that hyperplasia passes insensibly into carcinoma, and that this gradual change can nowhere be better studied than in the breast, and that tumour formation is here multi-, or rather omni-centric. Unless we adopt the absurd position that hundreds or thousands of 'embryonic' cells are scattered about in the ducts in cases of mammary cancer, these gradations completely knock the bottom out of the universal applicability of Cohnheim's theory. That it holds for some tumours I do not for one moment deny. I therefore agree with Cheatle, when he points out the importance of irritation in neoplasia. What the change from orderly to disordered and blastomatous proliferation may happen to be, we do not know. Perhaps in some cases it is no more than a difference in degree and extent of proliferation.

There can, I believe, be no difference of opinion as to the danger of cystic changes in the breast.

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INSTRUCTIVE MISTAKES.

A BILIARY MISTAKE AND ITS CORRECTION.

A WOMAN, age 37, presented herself for pain in the region of the gall-bladder. There was evidently cholecystitis. An exploratory operation revealed the presence of an inflamed gall-bladder containing a stone the size of a ripe acorn. Both bladder and stone were removed. In ligating the cystic duct, the mistake was made of drawing up a part of the common bile-duct, and throwing the ligature around the side of this duct. Five weeks later the wound opened and discharged bile. Before long the whole of the bile secreted was voided through the fistula, the motions became devoid of bile, and the patient gradually lost weight. Later the abdomen was opened again and a stenosis of the common bile-duct discovered about the middle of the tube. The fistula communicated with the proximal half. The question naturally arose as to what should be done, and it was decided to try the effect of dividing the stenosed portion longitudinally, and of suturing the opening thus made transversely. With some difficulty this was carried out. Bile escaped through the abdominal wall for ten days, and then ceased, the wound healed, the motions regained their colour, and the patient put on weight.

[A similar mistake was made in another case, in which removal of the gall-bladder was begun at the cystic duct. This mistake can be avoided by dissection downwards of the gall-bladder.]

FISTULA IN ANO AND AMŒBIC DYSENTERY.

AN ex-service man, age 22, presented himself at hospital complaining of a fistula in ano. The man was thin, and complained of 'diarrhœa' which he had had since 1918, when he was in France. He gave a history as well which suggested, at any rate, tuberculosis, and it was thought he might have a tuberculous colitis with its common concomitant, an anal fistula. A sigmoidoscope was passed, and it was evident at once that the lower bowel was greatly inflamed, thickened, and rigid; but the condition did not suggest tuberculosis so much as some chronic infection. Diarrhœa and pain still remaining urgent symptoms, it was decided to perform an inguinal colostomy in order to put the lower bowel at rest. The operation did not, however, produce the desired result, for diarrhœa still went on.

This man had never been east of France, and amœbic dysentery was not dreamed of until the condition obviously called for a closer scrutiny of the fæces than had previously been made, and then the amœba of dysentery was found quite easily.

CEREBRAL SYPHILIS OR CERVICAL RIBS.

A WOMAN, age 46, was admitted to hospital with the diagnosis of 'cervical ribs', because she had symptoms which suggested an additional rib, namely weakness and wasting of the ulnar group of muscles of the right hand, and *x* rays showed a cervical rib on each side. The diagnosis indeed was only doubted after a careful dresser had recorded in his notes that the patient had had a transient unilateral facial paralysis. This suggested the possibility of cerebral syphilis, and examination of the cerebrospinal fluid and the Wassermann test confirmed this diagnosis.

The cervical ribs which undoubtedly were present had no part in the causation of the muscular weaknesses.

SHORT NOTES OF RARE OR OBSCURE CASES.

A CASE OF PARAPLEGIA IN WHICH THE SECOND CERVICAL VERTEBRA WAS REMOVED: WITH A NOTE OF THE PATIENT'S CONDITION SEVENTEEN YEARS LATER.

By J. HOGARTH PRINGLE, Glasgow.

A schoolboy, age 14, who had been admitted to the Medical House of the Glasgow Royal Infirmary under the care of the late Dr. John Lindsay Steven on May 6, 1903, was transferred to my ward on the following day, as his condition was very urgent. He was suffering from almost complete paraplegia: the paralysis was complete in both his upper limbs and in the right lower limb, but not absolute in the left lower extremity.

The history given was that he had suffered from enlarged glands in the upper part of his neck two years prior to this, at which time he also complained of severe pains in the head. Ten months ago it was noticed that he had slight difficulty in moving his left upper limb, and that in walking his left foot dragged. At the end of two months this had cleared up, and the patient was apparently well until the onset of his present illness, five weeks before admission. At that time it was noticed that his right lower limb began to drag. This was attributed to a fall fourteen days previously. Three weeks before admission he had apparently lost all power in the right lower limb, and a week later power began to go from the right upper extremity. This was followed by loss of power in the left upper limb, and then in the left lower extremity. There had been no pain in the head and no vomiting since the present paralytic condition commenced. The patient lay on his back, his head fixed; the slightest attempt at movement of his head caused intense pain in the back of the neck. He was unable to move either of his upper limbs or his right lower extremity. Feeble movements of flexion and extension could be made in his left lower extremity at the hip- and knee-joints. Both knee-jerks were present and exaggerated. Ankle-clonus was present in both limbs. Superficial reflexes were present in both limbs, but diminished. Babinski's sign was not present. Triceps-jerk was present and exaggerated in both arms. The patient was unable to pass urine, and required a catheter from the time he went into the medical ward. The bowels had not acted after he came into hospital, and it was stated that he had been 'very constipated' for some days before admission. Respiration seemed to be entirely by the diaphragm. There was a pressure-sore over the occiput, and a fluctuating swelling extended from below this to the spine of the last cervical vertebra.

As the boy's condition was very critical an immediate operation was carried out.

An incision was made in the middle line of the neck over the whole length of the swelling, and pus evacuated. The laminæ of the upper four cervical vertebræ were found bared of their soft parts by the pus, and those of the second, third, and fourth vertebræ were removed, and a quantity of extradural pus was evacuated from the spinal canal. The second vertebra (the axis) appeared to be completely separated from all the surrounding soft tissues and to be entirely necrosed. The wound was packed with gauze. The patient stood the operation well, and the following day he was able to raise his right upper limb off the bed, to move both his lower extremities with some freedom, to move all the fingers of his left hand, and flex and extend the left elbow; but he could not raise the arm off the bed. On May 9 he had a dose of castor oil, which was followed by a volun-

tary evacuation of the bowel, and thereafter he had complete control of bowel and bladder. He made good progress until the middle of June, when an abscess on the left side of his neck required to be opened: another formed immediately afterwards on the right side, and was also opened, and it was found that the second vertebra was completely bare and could be palpated from all three wounds in the neck.

As all that remained of this vertebra appeared to be necrosed, as well as a considerable portion of the third vertebra and also the posterior ring of the atlas, at the end of July I removed the whole of the second vertebra except the odontoid process, the greater portion of the third, and the posterior ring of the first vertebra. The odontoid process could not be removed. The left vertebral artery was cut in the course of the operation, but the right one was avoided; it was, however, tied, in case of secondary hæmorrhage. Extension of the neck was continued for some time; the wounds granulated up, and he left hospital on October 10 with good power in all his limbs, and the wounds almost but not absolutely healed.

FIG. 385.—From a skiagram, showing the condition of the cervical vertebræ.

The patient was lost sight of, and was not seen until he again presented himself at the hospital on April 2, 1919, complaining of weakness in both upper extremities and left lower extremity, the left upper limb being worse than the right. He also complained of tingling sensations in the hands and fingers. He stated that until quite recently he had been able to work as a member of a riveting squad; but the weakness of his upper limbs, which came on two months ago, and which he attributed to an attack of influenza, had prevented his continuing work. He was taken into hospital. It was found that his knee-jerks were greatly increased, that both ankle- and patella-clonus were present in both limbs, but Babinski's sign could not be obtained. The triceps-jerk in both limbs was much exaggerated. Tactile sensation in the hands was not affected. His grasps with dynamometer (outside scale) were: right 35, left 40. He was able to flex and extend his head slightly, but rotation of the head was completely abolished. His neck appeared curiously shortened, but there was no angular deformity. He was kept in bed with extension applied to the spine. When he was dismissed, on June 3, the abnormal sensations had entirely disappeared and his grasps had increased to 70 and 75 respectively. An *x*-ray examination shows a curious deficiency in the cervical vertebræ. The exact number of vertebræ present is not quite clear, but it seems certain that two are absent. The seventh is quite distinct as a separate entity; the others appear to have become synostosed, at any rate through their processes, as shown in *Fig.* 385. It has not been possible to get a better radiogram in consequence of the fact that he is unable to rotate his head.

He was seen last on November 11, 1920, and seems to be much better than he has been at any previous visit here. The abnormal sensations have gone from his fingers and hands, though he says that his hands "feel as if they were shrivelling". His stereognostic sense seems to be defective, and he says he has difficulty with coins in consequence. His reflexes remain practically the same as noted above.

The record of this patient seems to be sufficiently interesting to justify its being reported. His condition on admission to hospital could scarcely have been more serious, and the very rapid recovery of function of the spinal cord after the relief of pressure was as gratifying as it was striking. It is hardly less interesting that he ultimately became so well that he was able to work many years in a riveting squad—a job which, if it brings in better pay than most others, certainly entails extremely hard work.

At the time of the operation in 1903, the opinion regarding the lesion was that it was a tuberculous condition of the cervical spine. After the abscess was opened and the state of the bones was seen, it appeared more probable that the real nature of the disease was a subacute osteomyelitis. Unfortunately there is no record of the temperature, nor of a bacteriological report on the pus, to be found at this date.

It is an interesting speculation as to how the 'slack' of the spinal cord became accommodated after the removal of the bone. Beyond the shortening of the patient's neck there is no sign of any deformity of his spine.

LIGATURE OF THE HEPATIC ARTERY.

By R. ECCLES SMITH, Barry, Glam.

Injury to the hepatic artery during the performance of choledochotomy has been held over the head of the surgeon like the sword of Damocles. Happily, so far I can find in the literature no case in which it has occurred. Here it necessitates deliberate ligature of the artery, and ends in recovery with apparently no ill effects, immediate or remote.

Mrs. W., age 59 years, more than reasonably stout, had been the subject of so-called 'bilious attacks' for a period of some years, until a final attack ended with a marked jaundice for some days, and a persistent slight icterus for three or four weeks, when she was referred to me with the true diagnosis of cholelithiasis with an impacted stone in the common duct.

Operation.—A good exposure of the site of operation was obtained by the 'Mayo Robson' incision. The fundus of the gall-bladder was freed of adhesions to the colon and the pylorus, and found to contain about 35 moderate-sized faceted stones. A larger stone was found fixed and immovable low down in the first part of the common duct. Owing to the inability to 'rotate' the liver, work on the common duct was carried out at a great depth. An incision over the stone failed to permit its evacuation, and on enlarging this incision, rather alarming arterial bleeding occurred. The stone was rapidly removed, and repeated unsuccessful attempts were made to pick up the bleeding point. Packing being of no avail, the hepatic artery was deliberately defined by dissection and controlled. As the general condition of the patient was not of the best, a ligature was passed and the artery tied. The hæmorrhage ceased instantly. Cholecystotomy and drainage of the common duct and right kidney pouch completed the operation.

After-History.—On recovery from shock, a fair degree of jaundice lasted for about ten days, and then rapidly disappeared. Escape of bile continued from the sinus for five weeks, and then ceased. Unfortunately parietal sepsis supervened, and a ventral hernia subsequently developed. For six months the patient remained free from any of her old 'bilious' complaints, and was extremely well, with no jaundice, no loss of weight. The urine was free from albumin and sugar. In the seventh month I again admitted her with all the signs and symptoms of an acute infection of the gall-bladder, slight rigors, temperature 102° to 103°, pulse 110, and tenderness over the gall-bladder. Expectant treatment was adopted for seven days. I then injected collosal manganese intramuscularly, and, after two injections at twenty-four hour intervals, the temperature dropped and remained normal until her discharge from hospital fourteen days later.

I have no doubt whatever that, in the depths of the wound, in making what appeared to be the usual incision into the common duct, I injured the hepatic artery—whether abnormally placed or distorted I do not know; but what I regarded as a surgical disaster, to be followed at least by some grave alteration in the general metabolism of the patient, fortunately proved to be of little consequence.

I am much indebted to Dr. Ernest Davies, Barry, for his able assistance, and to Dr. Neilson, Barry, for the trying adminstration of the anæsthetic.

CHOLELITHIASIS: NOTES ON A CASE WITH A CALCIFIED GALL-BLADDER.

By PHILIP TALBOT, Stalybridge.

W. L., male, age 56, a patient of Dr. Awburn, of Mottram, gave a history of having had attacks of biliary colic without jaundice for about fifteen years.

An *x*-ray examination showed the outline of a calcified gall-bladder containing calculi and a dilated and calcified cystic duct (*Fig.* 386).

FIG. 386.—Skiagram of calcified gall-bladder and cystic duct.

Operation, Feb. 28, 1920.—The gall-bladder, which was found buried in a mass of adherent omentum, felt very hard and stony, and was packed tightly with calculi. The cystic duct for about one-and-a-half inches was dilated to a diameter of three-quarters of an inch, its walls showed calcareous plates, and it also was packed with calculi. The last inch of the cystic duct was normal in size and appearance. The gall-bladder and dilated duct were removed. There were no calculi in the common duct.

SEVERE INTESTINAL HÆMORRHAGE FOLLOWING APPENDECTOMY.

By F. C. PYBUS, Newcastle-on-Tyne.

This complication following appendectomy is unique in the author's experience, and seems worthy of record.

W. T., age 47, was admitted to the North Riding Infirmary, Middlesbrough, in July, 1920, as a case of chronic appendicitis. When 15 years of age he had what appeared to be a mild attack of appendicitis lasting three or four days. The attack subsided; but since then he has had several recurrences at almost yearly intervals. Seventeen years ago he commenced to pass blood per rectum, and since then he has occasionally passed similar blood when constipated. The blood was bright in colour and occurred at stool.

Fifteen years ago he had a very severe attack of pain in the abdomen. The pain was most intense in the neighbourhood of the umbilicus and in the appendix region. During the attack, which lasted three weeks, he was very constipated, but had no sickness or vomiting. Since then the attacks of pain had been gradually getting worse. For many years he had suffered from gastric trouble—heartburn, waterbrash, and ulcers on the tongue and lips.

On July 22 appendectomy was performed. There was a post-operative rise of temperature to 100° which lasted twenty-four hours. On the fourth day his temperature rose to 101°, and on the following day reached 102°, with pulse 130. On the eighth day his temperature was normal, and it remained so except for an occasional rise to 99° until the thirteenth, but during this period his pulse remained between 90 and 120.

On Aug. 12 he passed two pints of dark blood from the bowel, together with a clot about the size of a small orange, which was also dark in colour. All this time he had a slight tenderness in the right iliac fossa, but no pain. After this the bowels were moved every second day by means of enemata, but at each action a little altered blood was passed. During this time he had fever up to 100° till Aug. 23, on which day he had a very severe hæmorrhage from the bowel, followed by a subnormal temperature.

While in Middlesbrough I was asked by Dr. George Longbotham to see him. On examination he was profoundly anæmic, slightly tender over the operation area, and had small hæmorrhoids which did not appear to have given rise to any recent bleeding. I was unable to give any definite opinion as to the cause of the hæmorrhage, and could elicit no symptoms or signs of a duodenal ulcer. It was decided to perform a laparotomy, which I carried out on Aug. 30.

On opening the abdomen the operation area was first examined. A coil of the lower end of the ileum was found adherent near the appendicular stump, and this part was put aside for further investigation. The rest of the viscera were examined, and no evidence of any ulceration or lesion could be detected. A re-examination of the cæcal area revealed a coil of ileum adherent near the apex of the cæcum and to the mesentery of the appendix, which was very much thickened. The ileum was separated off, and its raw edges were covered up. A small perforation was found at the apex of the cæcum, near what must have been the stump of the appendix, and, adjoining this, a hæmatoma about the size of a filbert nut was found between the layers of the appendicular mesentery, containing some recent and also laminated clot. On removal of the clot, bleeding occurred. This was controlled by a fresh ligature of the mesentery proximal to the hæmatoma. The perforation of the cæcum was then closed.

Except for some slight post-operative fever and œdema of the leg, he made a good recovery, and is now well.

The explanation of this condition seems to have been that the appendicular artery was punctured, and formed a hæmatoma in the mesentery, which became adherent to the cæcum and an adjacent coil of ileum. This, with or without suppuration, perforated the cæcum and gave rise to the melæna. It would appear safer in these cases, when the appendicular vessels cannot be seen and avoided, to ligature the mesentery after clamping rather than to puncture it with a needle or forceps.

REVIEWS AND NOTICES OF BOOKS.

Privy Council Medical Research Council: First Report of the Committee upon Injuries of the Nervous System. 1920. London: H.M. Stationery Office.

A VERY strong Committee has been occupied for nearly two years in investigating and recording the effects of injuries to the peripheral nerves, and this Report gives fully the results of their labours. In itself it constitutes the most complete account of the subject with which we are acquainted; and it provides us with a mass of detailed information of the highest value. Much of the ground has doubtless been covered by the published papers of the last few years; but it is nowhere so completely surveyed as in this Report, and the judicial analysis of the physician and anatomist adds greatly to the value of surgical investigation.

While it would be impossible to review briefly the mass of detail here supplied, we may refer to a few salient points. In cases of extensive separation of cut ends a two-stage operation is strongly advised, the end bulbs being tied together at the first operation, the nerve stretched for two or three weeks, and resection with suture then completed. For sutures, linen thread and silk are preferred to catgut, as the latter "causes more cellular reaction" and "it is doubtful whether this disadvantage is compensated for by its greater absorbability". A 'retention' suture through the nerve is condemned, as is continuous suture of the cut ends, which is stated to interfere with the escape of exudate from the interior of the nerve, and to be liable to produce a stricture. All methods of envelopment of the sutured ends are condemned.

As regards the vexed question of nerve-grafting, it is stated that "when it is impossible to obtain approximation of the ends of a divided nerve, the outlook is extremely bad, for there is at present no known method which can take its place. It is therefore of the utmost importance that every possible manœuvre should be employed and every means exhausted for securing end-to-end approximation before trying the last resort of grafting. Lateral implantations and flap operations are only mentioned here to be condemned. There is nothing in what is at present known of the processes of regeneration of nerves to justify them, and no unimpeachable evidence that they have ever been successful. Bridging of the gap with a piece of nerve, whether living or alcoholized, is justified on histological grounds, by experimental work on animals, and by a few clinical cases of very imperfect recovery. But in the present state of our knowledge nerve-grafting ought to be regarded as a last resort."

In an addendum are quoted some important cases of bridging by graft or by 'lateral implantation' (Joyce), showing that "in exceptional cases grafts have produced more successful results than previous experience had justified any hope for"; but "the result of these investigations in no way alters the view, expressed in the text of the Report, that nerve-grafting should only be adopted as a substitute for end-to-end suture in those very rare instances where it is absolutely impossible to bring about direct approximation."

The whole Report is not only valuable in itself, but an admirable example of the value of collective investigation of the results of treatment by a committee of men with many-sided views.

Collected Papers of the Mayo Clinic, Rochester, Minnesota. Vol. X, 1918. Edited by Mrs. M. H. MELLISH. Large 8vo. Pp. 1196 + x. 1919. Philadelphia and London: W. B. Saunders Co. Ltd. 36s. net.

IT is no doubt a result of the late war that the character of the bulk of the papers which make up this volume differs somewhat from that of its forerunners, for naturally many of the clinicians had their minds fully occupied with other matters. This is not meant to indicate any falling off in quality from their former high level, though one must as a surgeon confess to a sense of personal loss in the relative absence of those comprehensive and instructive papers on abdominal surgery from which we always derived a degree of educational advantage which no other surgical publication competed with.

Of the clinical articles, chief place must be given to that on the *Cutaneous Aspects of Tuberculosis*, by J. H. Stokes; this should appeal to the surgeon no less than to the dermatologist, for the author gives some most illuminating suggestions as to the relationship of the surgical treatment of tuberculous glands and tuberculides, and urges both a sounder selection of cases for operation and its more thorough performance.

In Balfour's practical and beautifully illustrated article on *End-to-end Anastomosis between the Small and Large Intestine* we miss any reference to Lane's practice of this method during the past ten years or more. The same author's further paper on *Cautery Excision of Gastric Ulcer* appears to vindicate entirely the claims made in the first article for this method, as judged by observations of the results which it has given; the paper contains much practical advice as to the choice of cases for this method, and points in its technique.

We have read Judd's observations or review of *The Recurrence of Symptoms following Operations on the Biliary Tract* with the greatest interest, for the question of cholecystectomy *v.* cholecystotomy has vexed us for some years. We are not aware of any other observations on operative results which have comprised anything like the large number of cases—over 2000—which Judd reviews, and from the study of which he concludes by favouring removal of the gall-bladder as the operation of choice. We must admit to being not quite convinced, and for this reason: if it is admitted that where the gall-bladder alone is involved cholecystectomy is the best operation, it does not necessarily imply that this is also so when, at the first operation, stones are found in the common duct or the history suggests infection of the bile-ducts. If it is agreed that after exploration of the common duct drainage is essential, then it appears to us better to suture the duct itself and drain the gall-bladder rather than to remove the gall-bladder and be compelled to drain the common duct. When infection and stone formation have already involved the ducts, removal of the gall-bladder can no longer be advocated as a preventive measure, and appears to us to lose its chief indication. Our views are, of course, founded upon a very small experience when compared with the Mayo clinic's 2000 cases, so we should much value Judd's opinion upon the point raised.

Mann's papers on *Surgical Shock* contain an adequate review of the present beliefs, and if they do not contain original observations or suggest any fresh hypothesis as to the causation of shock, they throw out some helpful suggestions. We turned with pleasant expectation to MacCarty's *Biological Conception of Neoplasia*, but it was altogether beyond us, and appears too involved and elaborate to provide a practical basis for teaching purposes.

If no special attention is called to shorter papers, this is not intended to convey that they are of less value than those which have been referred to. To many surgeons the Mayo clinic volumes are their most valuable reference library, and we trust that enough has been said of the contents of the volume under notice to indicate that it does not fall short of its predecessors in interest to surgeons of all types.

Lippincott's Quick Reference Book for Medicine and Surgery. By George E. Reiberger, A.B., M.D., Johns Hopkins University. Philadelphia and London: J. B. Lippincott Company. 63s. net.

This extensive work reviews in a clear and concise manner the causation, symptomatology, clinical features, prognosis, and treatment of the various disorders met with in the practice of general medicine and surgery, including their specialized branches. It also contains a well-chosen list of the drugs in common use, with a brief description of their nature, dosage, and mode of action.

The text is fully and admirably illustrated. The book has been written primarily to meet the needs of the general practitioner in providing him with reliable and readily accessible summaries of the diseases which he may encounter; this object has been well attained, and fully justifies the immense labour which its achievement must have entailed.

Surgical Pathology and Morbid Anatomy. By Sir Anthony Bowlby, K.C.B., F.R.C.S., and Sir Frederick W. Andrewes, M.D., F.R.S. Royal 8vo. Pp. 651, with 210 illustrations. Seventh edition, revised. 1920. London: J. & A. Churchill. 30s. net.

The seventh edition of this work is up to the standard set by its predecessors, and we believe that it will command the popularity which they have always enjoyed.

The newly added chapters on tetanus, gas gangrene, and shock are good, and the illustrations throughout the book have been greatly improved, though there are still, perhaps, not quite enough of them.

On the whole, however, we must confess, on reading through it, to a sense of disappointment. The authors' claim in their preface to have revised the whole book is scarcely borne out by the obvious neglect of some of the most important sections. In the chapters on diseases of bone, for instance, no mention at all is made of osteitis fibrosa, and the description of the odontomes is so antiquated as to be not only useless, but misleading to the student. Surely our knowledge of these tumours has not remained stationary since the publication of the late Sir Frederic Eve's paper in 1883. In the chapter on diseases of the breast, again, the recent work on Paget's disease of the nipple might have been mentioned, and we thought that the term 'sarcomatous', as applied to the rapidly-growing fibro-adenomata, had long since been abandoned. In the section on the kidneys the misleading statement is made that sarcoma is the commonest malignant tumour, and

the terato-blastomata of infants are not clearly dissociated from them. It is a pity that these and other similar instances of lack of revision should mar an otherwise excellently written book, especially as it is the only one on surgical pathology commonly read in, at any rate, the London medical schools.

A Synopsis of Surgery. By Ernest W. Hey Groves, M.S., M.D., B.Sc. (Lond.), F.R.C.S. (Eng.), Surgeon to the Bristol General Hospital, Lecturer on Surgery in the University of Bristol. Fifth edition. 8vo. Pp. 628, illustrated, 1920. Bristol: John Wright and Sons Ltd. 17s. 6d. net.

The book has been revised, some excellent outline drawings in colour have been added, and methods evolved during the war have been incorporated; the technique of primary and secondary suture of wounds is described; but the new methods of plastic surgery are not mentioned. There is a clear account of blood transfusion, with the group tests of donors and recipients.

The sections dealing with fractures have been brought up to date by the inclusion of recent non-operative and operative measures, and many new illustrations added. In discussing the treatment of acute appendicitis, the author does not emphasize the urgent necessity of immediate operation, or point out the serious consequences which may result from expectant treatment. In the description of the surgical treatment of gall-stones, it is not clear when cholecystotomy or cholecystectomy is indicated. The book should appeal to busy practitioners and students as a handy work of reference giving the outlines of surgical diagnosis and treatment.

Chirurgische Anatomie und Operationstechnik des Zentralnervensystems (Surgical Anatomy and Operative Technique of the Central Nervous System). By Tandler and Ranzi. Pp. 159, 94 illustrations, mostly coloured. 1920. Berlin: Springer. 56 marks.

This handsomely illustrated volume is the joint production of a distinguished anatomist and surgeon in Vienna, and its scope is clearly indicated by its title. There is no discussion of the conditions which call for operation or of the results of operation; but the surgical anatomy of the brain and spinal cord with their coverings is fully described and illustrated, as are the details of operative methods.

Probably the most striking feature of the book is the profusion of illustrations, which are in part diagrammatic and in part actual pictures of the stages of operation. These are so numerous and clear that to anyone reasonably familiar with the subject they convey their own interpretation and make the text almost unnecessary. For English readers, perhaps, the principal value of the work will thus lie in its graphic representation of anatomical detail; and it will find a useful place on the table of the surgeon who is only occasionally called upon to perform the more elaborate operations upon the central nervous system. The appended bibliography is mostly confined to German literature.

The Student's Synopsis Series: Surgery: By Ivor Back, F.R.C.S., Surgeon to St. George's Hospital, and A. Tudor Edwards, F.R.C.S., Assistant Surgeon to Westminster Hospital. 8vo. Pp. 480. 1921. London: J. & A. Churchill. Price 15s. net.

The authors have attempted to give the main facts of surgical theory and practice in less than five hundred small pages, and in this rather difficult task they have shown some skill in the selection of the most important subjects, in the omission of unimportant ones, and in great condensation.

The price charged seems rather high for a small unillustrated book, but we suppose that students will be willing to pay this if it helps them to pass an examination.

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